4605 4609 4772 X-Y 4603

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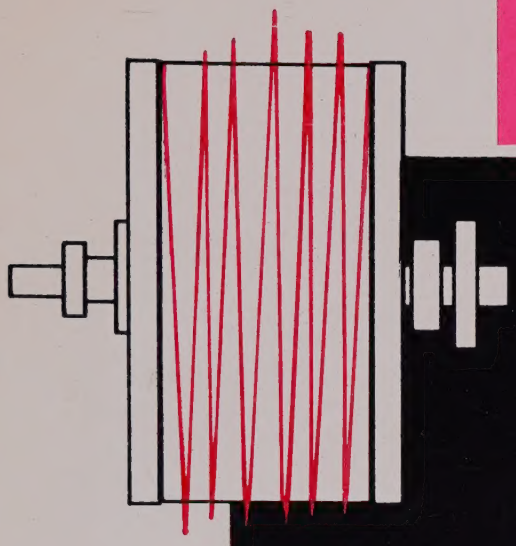

# DYNAMOMETER OPERATING INSTRUCTIONS

MAGTROL, INC.

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BUFFALO, NEW YORK 14224

# MAGTROL DYNAMOMETERS AND ASSOCIATED EQUIPMENT

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# 1. DYNAMOMETER AND MODEL 4605 or 4603

## 1.1 Unpacking and Set Up:

Unpack the dynamometer, control unit and Digital Readout from their respective shipping containers. Save the cartons and all packing material. In the event of shipping damage the carrier should be immediately notified. This procedure is essential if a damage claim is to be initiated.

Place the dynamometer on a smooth flat surface. The readout and control unit may be set up in any manner within the limit of the interconnecting cable lengths; approximately four feet.

Connect the three interconnecting cables:

a. The 14 terminal cable into the dynamometer and readout.
b. The 2 pin brake control cable into the power supply.
c. The standard 117 VAC line cord from the dynamometer, to the switched AC outlet on the rear of the Model 4605 or 4603 digital readout.

Be sure the ON-OFF switch is off and plug in the remaining line cords into a suitable 117 VAC 60 Hz power source.

### 1.1.1 Display Hold

Two miniature banana jacks are located on the rear panel of the 4605 digital readout. When either or both of these are shorted the readings are held indefinitely. If this function is desired, use either a D.P.S.T. (normally open) foot operated or toggle switch.

NOTE: For proper operation of the instrument the line voltage source should remain within the limits of 105 to 125 VAC.

## 1.2 Operation:

Before switching the power supply model 4636 on, check that the TORQUE CONTROL knob is fully CCW. (OFF). If the special power supply model 4609 is used, refer to that section for set up. Turn on the equipment. After a few seconds the axial cooling fan should be clearly audible in the dynamometer head. Spin the dynamometer output shaft; it should spin freely and the digital speed indicator should display an RPM reading. Digital torque is indicated on a Weston digital voltmeter. The manufacturer specifies a minimum warm up period of 1/2 hour. As a practical matter, the readings should be within $\pm$ 1 digit after approximately five minutes warm up.

After fifteen minutes, if the torque reading is not within $\pm$ 1 digit (Flashing 1999, or 001) with the dynamometer shaft stationary and nothing connected to it, refer to paragraph 1.4.2. Otherwise the unit is ready for operation.

1.2.1 Motor Attachment:

Never solidly couple shafts with bored out steel sleeves or the equivalent. A soft coupling is essential. For example, "Lord Mfg. Co., Erie, Pa. Type J-1211" is adequate, or any equivalent type.

Good shaft alignment cannot be overstressed since poor alignment results in coupling losses. Generally, parallel off-set is more harmful than angular off-set, but both should be minimized.

1.2.2 Fixturing:

Any torque applied to the motor shaft is equally present on the motor frame. It is essential to secure the motor to the dynamometer base plate.

The base plate on Magtrol dynamometers is aluminum tool plate, (cast). This has the advantage of being very flat and unstressed. However, tool plate is soft and "gummey" to machine. If motor fixtures are to be mounted to the base plate, chip clearing and generous use of cutting oil is recommended when drilling and tapping.

1.2.3 Motor Testing:

With the motor connected and ready for test, apply power to the motor. Place the shaft direction switch to the direction (CW or CCW) that the dynamometer shaft is rotating. If the motor is of a type where danger of high speed "run away" or excessive speed is a hazard, increase the torque control until enough torque is applied to maintain a safe upper limit. In either case, some torque will be present even with the torque control off, and the value should be regarded as a component of the data (refer to paragraph 1.5). Select the desired resolution of speed. The X 1 position displays the speed to the nearest 1 RPM, at 1 second intervals. The X 10 position displays speed to the nearest 10 RPM at .1 second intervals.

As the torque control is advanced CW, torque will be applied, the speed will typically decrease and these values will be indicated on the readout instrument.

A very important factor is kinetic power absorption. This limitation is covered in paragraph 1.7.

NOTE: After the shaft of a motor is coupled to the dynamometer, and either rotating or stationary, zero torque will not necessarily be indicated. Both the dynamometer shaft bearings and the motor friction drag may apply a component of torque. Therefore, statically a reading of a few ounce inches is normal.

## 1.3 Operating Principle:

All Magtrol dynamometers are equipped with a hysteresis brake. This is the means for applying torque to the test motor. Referring to figure 1., the rotor, a cup shaped element in the brake, is attached to the shaft and supported by permanently lubricated ball bearings. The stator assembly provides an articulated and precisely defined magnetic field through the rotor. Since the stator assembly is composed of iron, the strength of the field, magnetically, is determined by the ampere turns of the stator coil. The rotor resists rotation dependent upon this field strength, thus resistance to rotation (torque) is dependent upon applied current.

As torque is developed on the rotor by the test motor, the stator assembly reacts to precisely the same amount. However, it is restricted from motion, except for a few degrees, by the load cell.

Since the shaft extends through the brake assembly, a photo optical pick up is installed at the end of the shaft for speed transducing. Light from the exciter lamp beams directly into a high speed silicon photo-cell. Between the lamp and the photo-cell is a clear plastic disc with alternate clear and opaque segments. As the light is interrupted the resistance of the photo-cell changes. With the application of a bias current to the cell, the resistance change results in generation of voltage pulses, the frequency proportional to the shaft speed.

### 1.3.1 Salient Pole Effect: (Cogging)

If power (Torque Control CW) is applied to the dynamometer at rest, the rotor and shaft will be locked by the amount of torque imposed. This is essential for motor locked rotor data. However, if the current is subsequently removed, in the absence of rotation, a history of the stator tooth structure is temporarily imposed on the rotor. (The rotor is a permanent magnet material). This condition is frequently confused with defective bearings or other defects. It in no way impairs the accuracy or performance of the equipment. The cogging may be eliminated by rotating the shaft at any speed above a few RPM, re-establishing the same value of torque, then decreasing the torque to zero <u>while the shaft is rotating.</u>

## 1.4 Calibration:

### 1.4.1 Torque Explanation:

A simple means of calibration is provided by the use of the torque calibration beam supplied with the instrument. It is desirable to periodically check calibration. The calibration beam is supplied with two holes, one on each end. These holes are precisely spaced from the center of the beam.

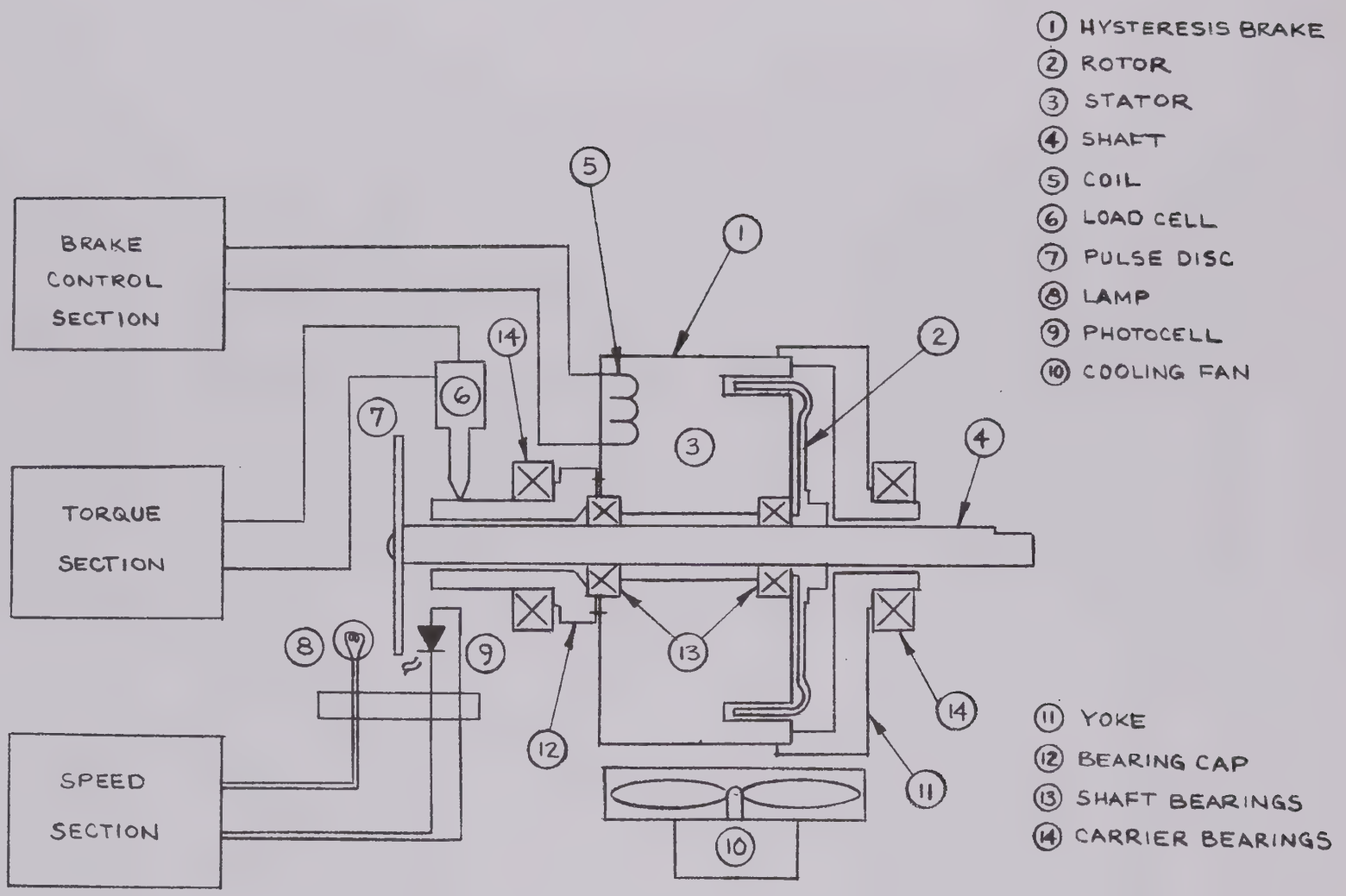


FIG. 1. MECHANICAL SCHEMATIC DIAGRAM

The actual distance is engraved on the beam, and varies with the size or specific dynamometer model . Refer to Figure 2.

As mounted, the center of the beam is directly on the centerline of the shaft. The torque applied to the shaft will be equal to the weight supported by the beam times the distance in inches. Figure 2 is a sketch of a typical calibration beam showing a 2 oz. weight attached at 5". The torque applied to the shaft would be 2 oz. x 5" = 10 oz.in. Since the calibration beam supplied with the equipment is not graduated, simply fasten a loop through the hole to support the weight. To insure accuracy a bubble level is supplied with the calibration beam to maintain the beam in a horizontal position throughout the entire calibration procedure. The following will result in accurate calibration of at least . 25% $\pm$ 1 digit.

1.4.2 Calibration Procedure:

a. Rotate the dynamometer shaft such that the flat on the shaft is facing down.

b. Advance the torque control CW to full torque.

c. Place the beam on the shaft with the level up.

d. Tighten the locking screw against the flat on the shaft.

e. Set the CW-CCW shaft direction switch CW.

f. Be sure the beam is very still and not oscillating, set the ZERO TORQUE POTENTIOMETER on the dynamometer rear panel for zero indication (000).

g. On the right hand side carefully attach a weight of a suitable capacity to provide full scale, or approximately a full scale torque value. It will be necessary to force the beam CW or CCW to a level position. Check the torque reading and correct with the calibration control on the rear panel as required.

h. Repeat the procedure (Starting at (f) above ) with the shaft direction switch CCW. Place the weight on the left hand side of the beam. If the torque value varies more than .25% from the CW calibrated value, refer to paragraph 1.10 Alignment, Mechanical. (Be sure to adjust the beam horizontally.)

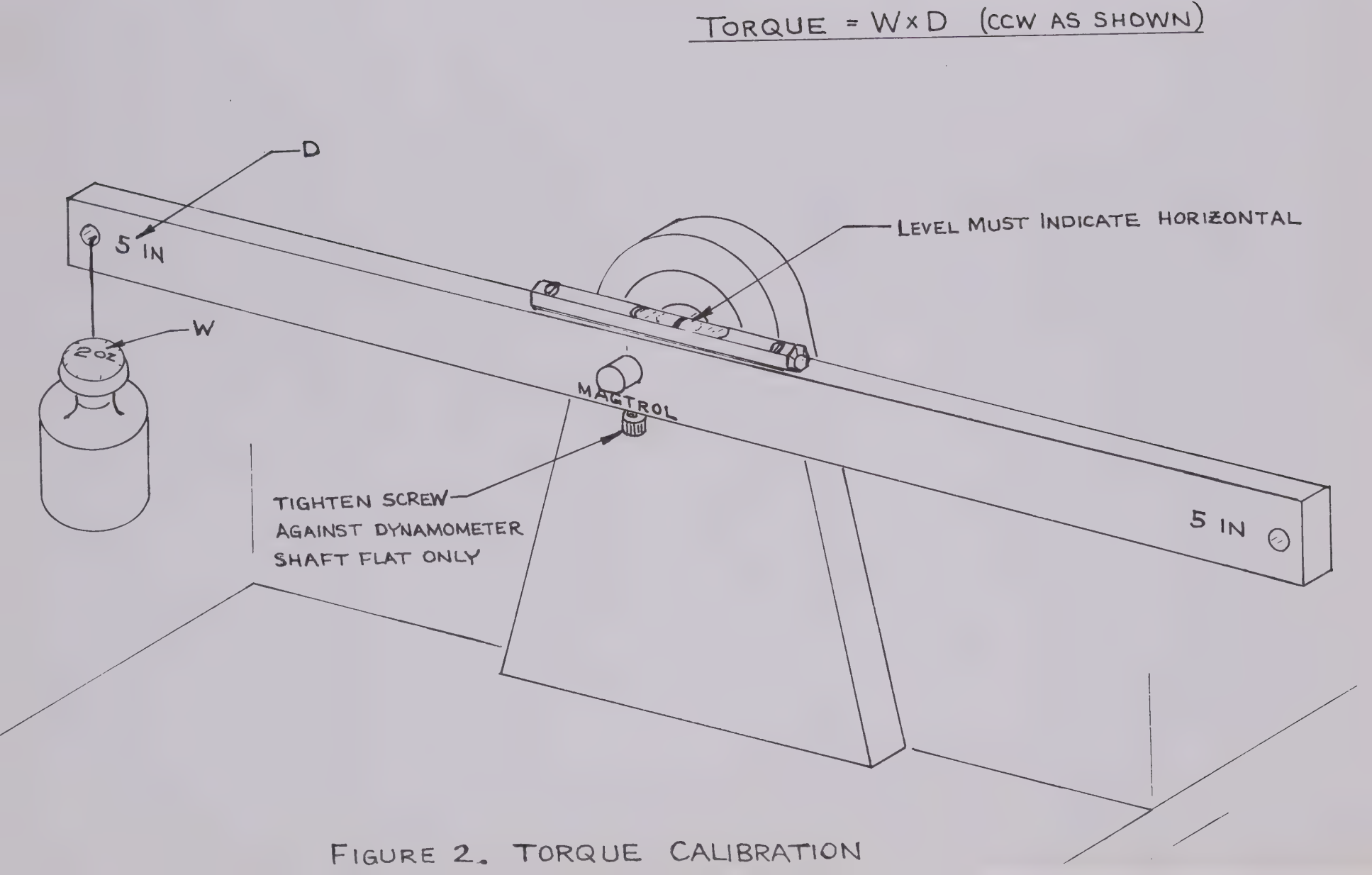


FIGURE 2. TORQUE CALIBRATION

NOTE: Do not confuse a directional error at full scale torque, with a zero imbalance condition with the shaft free and zero torque applied. These are two separate conditions. When calibrating full scale accuracy always make certain that with the weight removed from the beam, the torque readout displays zero. If this zero shifts when switching the "shaft direction switch", this indicates that some amplifier imbalance has been applied, by the "zero torque" potentiometer on the rear panel, to compensate for the Weston meter being off zero balance. However, the calibration is still valid and test data is accurate if the procedure is followed.

A further explanation with corrective action is outlined in paragraph 3.1.

1.4.3 Speed:

There is no adjustment or calibration procedure for the speed reading. Accuracy is dependent upon the 60 cycle line frequency which is typically better than .02% (subject to local conditions). A speed error would be indicative of a component failure. The most simple method for determining accurate speed display, is to operate the unit from a known motor such as a 2 pole synchronous, or other induction motor. Switch the X 1 - X 10 switch below the readout to establish correct $\div$ 10 scaling.

1.5 Mechanical Friction:

Some mechanical friction must exist due to the stator carrier bearings. These bearings are non-loaded, stainless steel, and contains only a light amount of thin oil. During normal operation enough vibration is present to allow these bearings to "settle". However, with the dynamometer at rest and shaft disconnected, they may reflect a "stickiness" of .1% or less. The shaft (running) bearings cannot introduce any error, regardless of their condition, since they are supported in the stator assembly and any torque required to rotate them is read as part of the indicated torque value.

1.6 Windage:

Dynamic windage error is a function of the dynamometer size and the speed at which the unit is operated. Currents of air are generated on the rotor surface. Most of this is tangential to the rotor surface and impinges on the brake stator reaction member, resulting in a torque reading and is not error as such. However, some air must be dissipated as simple pumping loss and therefore uncompensated.

Since the rotor is inherently a smooth surface, the practical value of windage pumping loss is small and difficult to establish quantitatively. Tests conducted on all sizes of Magtrol dynamometers indicate that at speeds approximately 25% above catalog maximum rating, the loss (error) is an order of magnitude equal to the best possible torque resolution. Expressed as a percentage of full scale this would be in the range of .025 to .25% with the larger figure tending toward the smallest capacity dynamometer.

1.7 Power Dissipation:

All Magtrol dynamometers are absorption types. With high torque and high speed there are ultimate limits to which the equipment may safely absorb kinetic energy. The actual power absorption member is the rotor portion of the brake assembly.

Due to the close proximity of the rotor to the stator assembly heat transfer to these members is rapid, therefore little thermal gradient exists. This aids the temperature problem since there is a mass for "heat sinking" and thermal radiation. The maximum operating temperature is rated at 100°C. in consideration of bearing lubricants. This upper limit may occur by either moderate power input for a long period of time, or high power for a short period of time.

To remain within safe limits for high power inputs, refer to the following power-time curves. From a knowledge of torque and speed or HP, watts may be readily determined by the following formulas:

$$1 \text{ HP} = 746 \text{ Watts}$$

or in the case of torque and speed

$$\text{HP} = \frac{Q \times N}{5252} \qquad \begin{array}{l}\text{Where } Q = \text{lb.ft.} \\ \qquad\quad N = \text{RPM}\end{array}$$

or a less accurate, (.8%) error, more simple formula:

$$\text{HP} = Q \times N \times 10^{-6} \qquad \begin{array}{l}\text{Where } Q = \text{oz.in.} \\ \qquad\quad N = \text{RPM}\end{array}$$

For Example:

1/10 HP = 100 oz.in. at 1000 RPM

Example: HD 700 Dynamometer and AC motor rated at 325 oz.in. at 1710 RPM

Therefore: $\text{HP} = 325. \times 1710 \times 10^{-6} = .55$ HP  Watts = $.55 \times 746 = 410$

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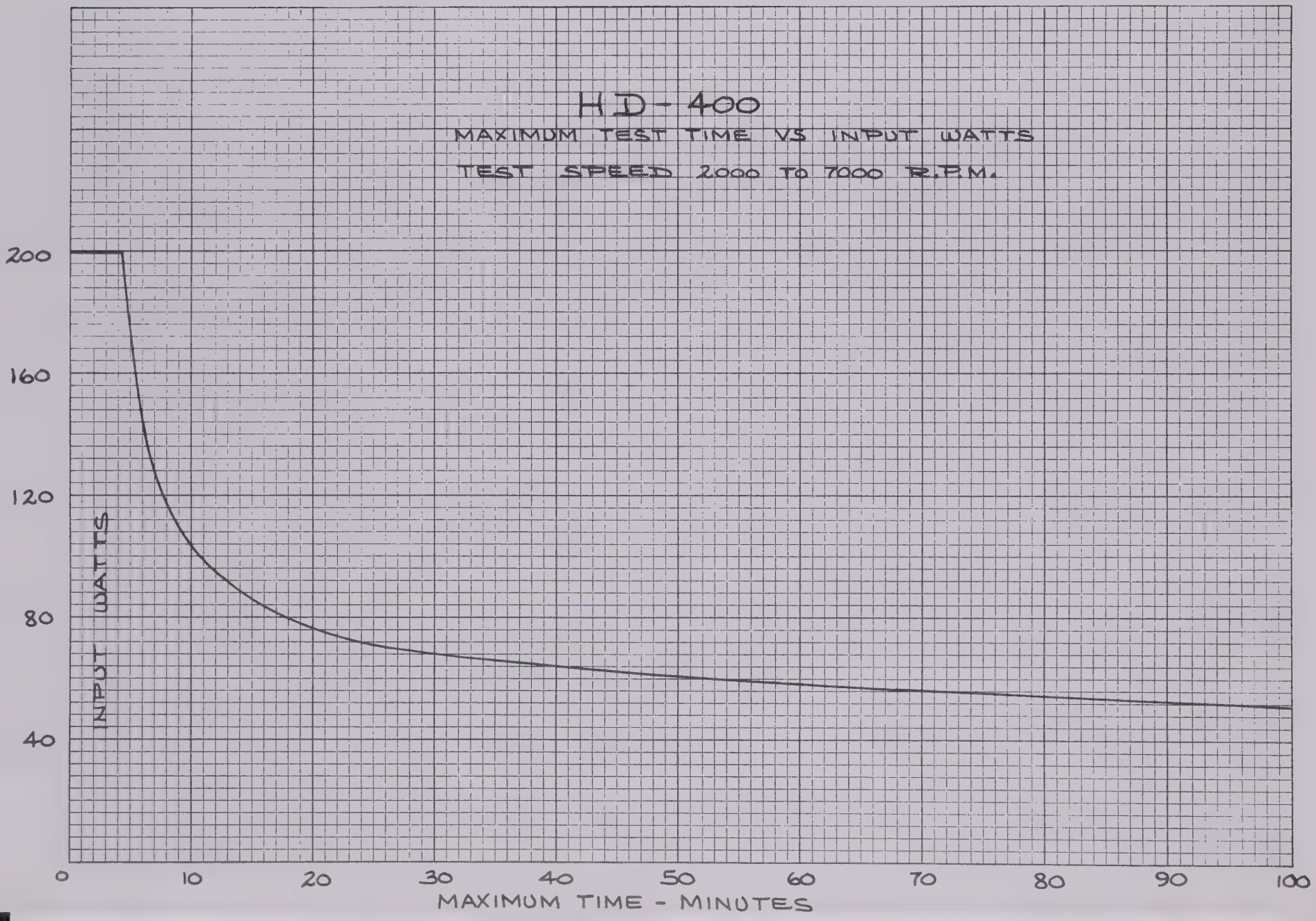
10 X 10 TO THE INCH
CHARLES BRUNING COMPANY, INC
MADE IN U.S.A



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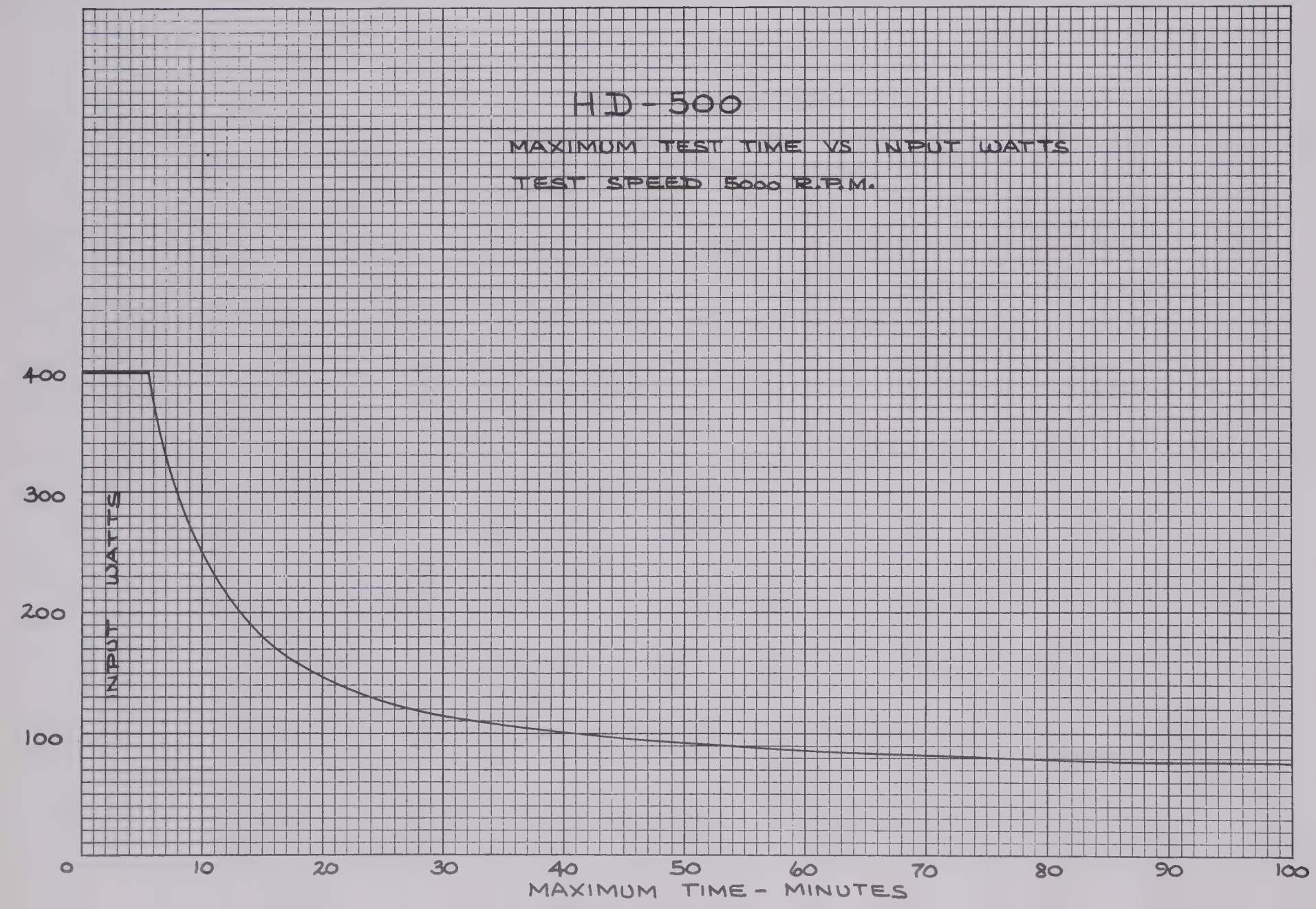

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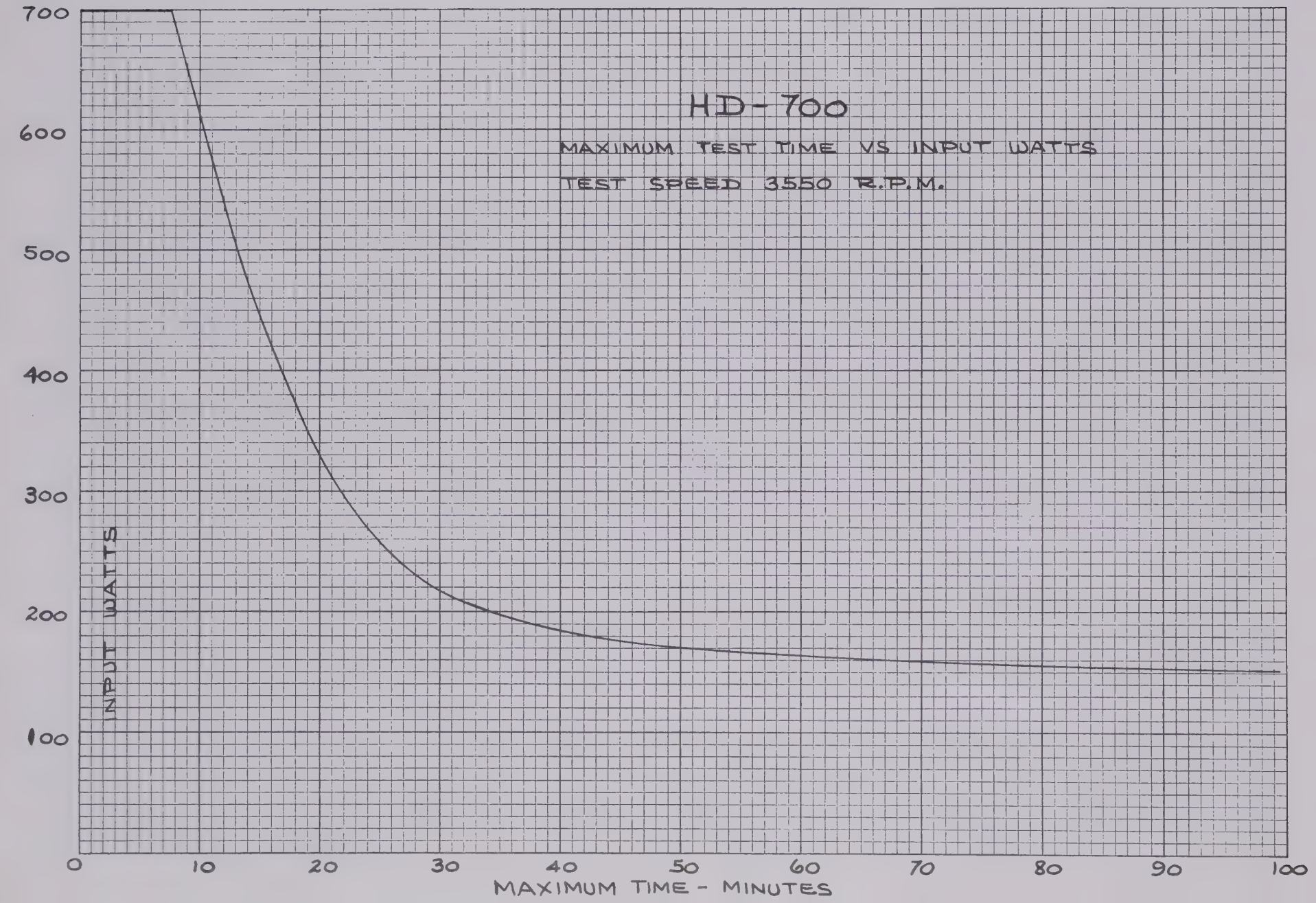

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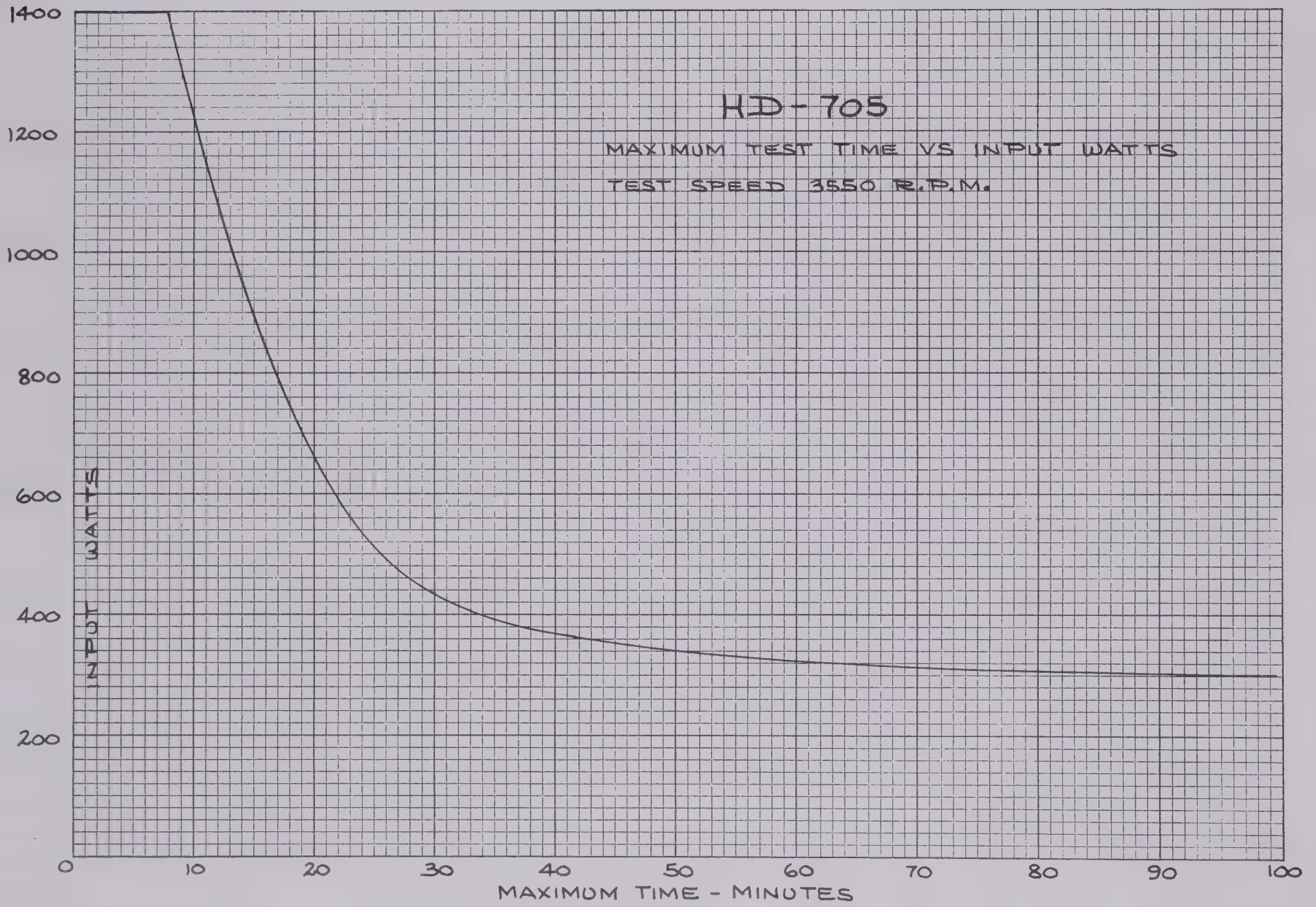

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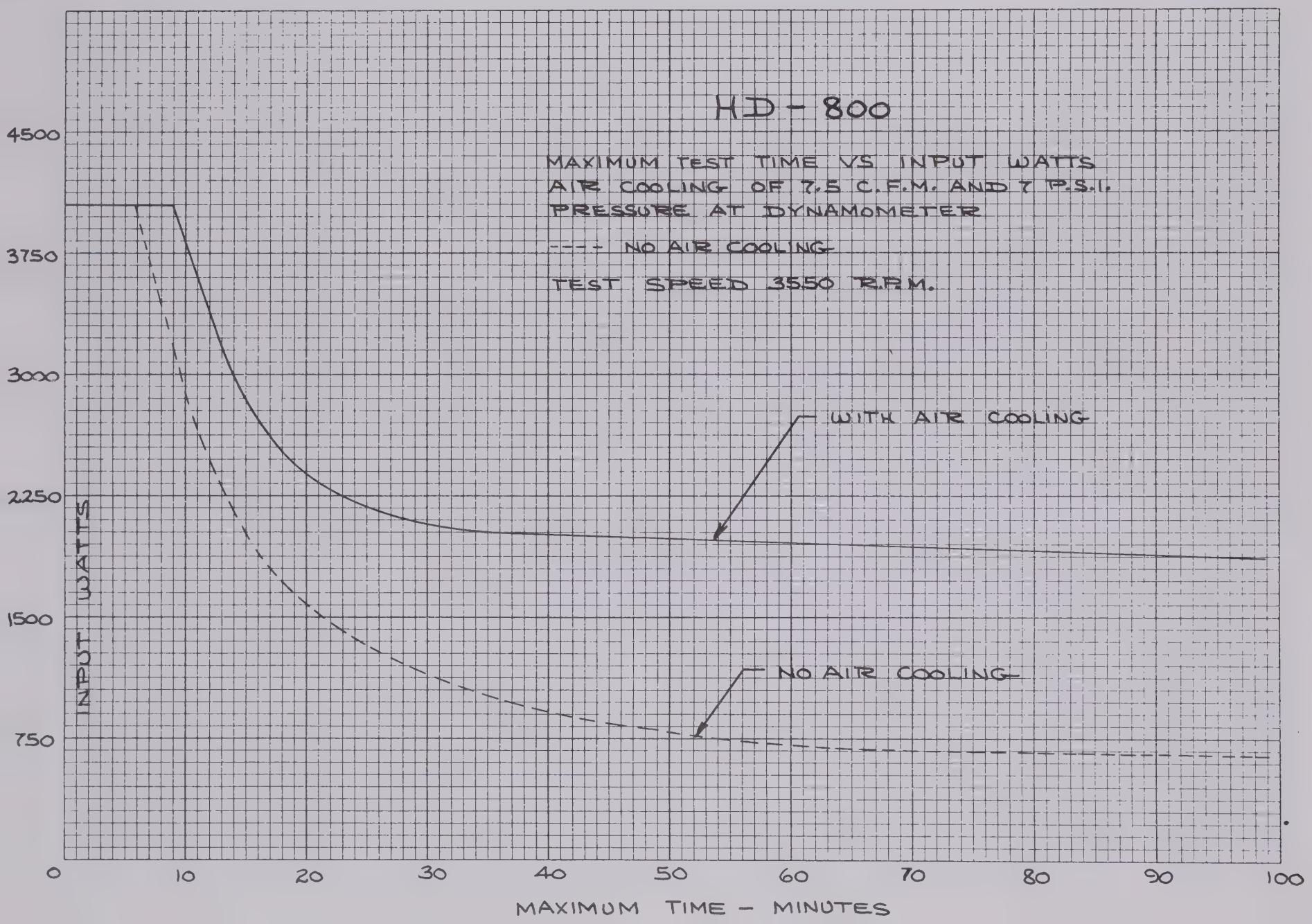

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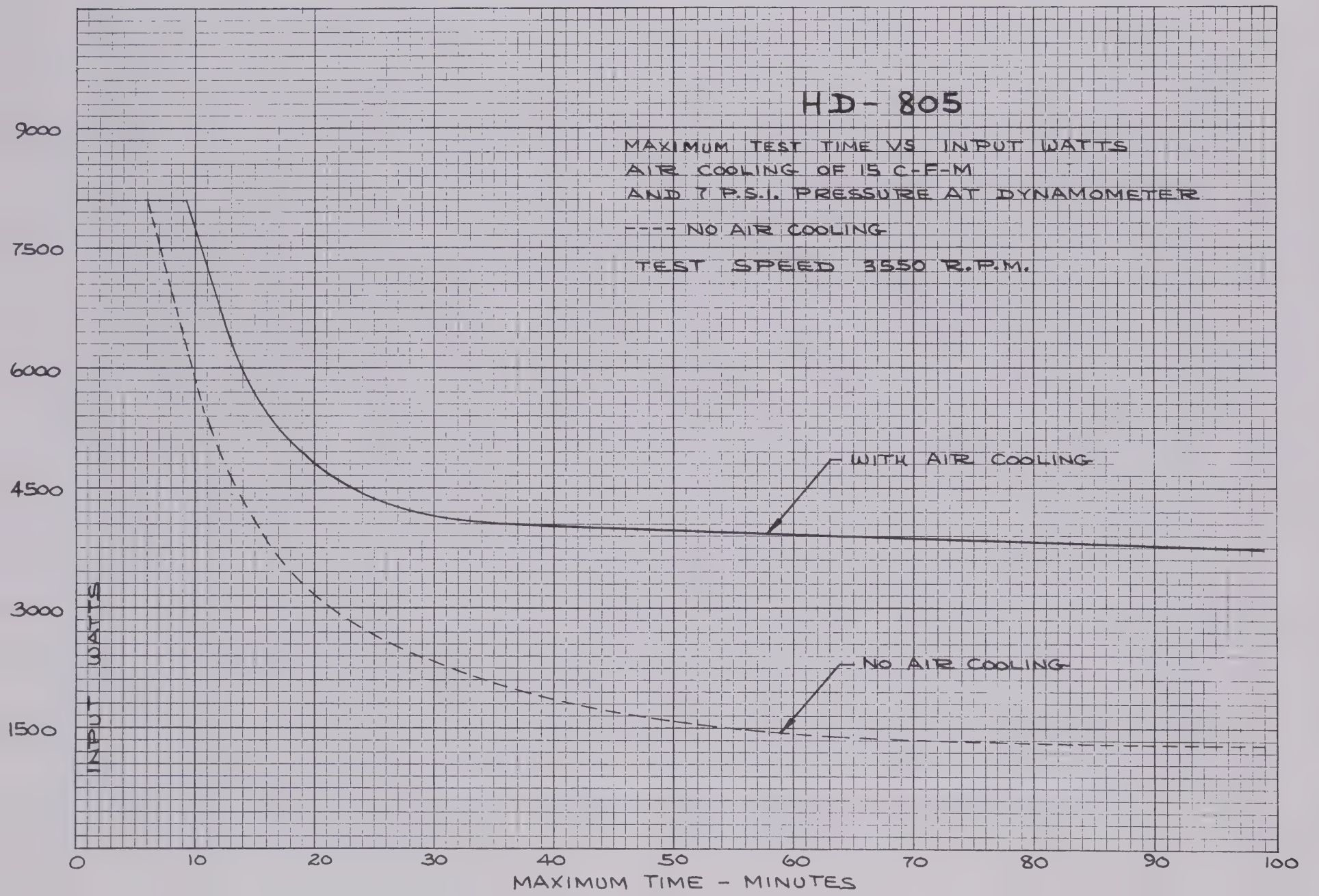


Referring to the curves for the HD 700, we see that the instrument will absorb 410 watts for 16 minutes. This will result in the brake reaching a temperature of 100°C.

1.8 Maintenance:

The only item requiring periodic maintenance is the air filter located inside the dynamometer enclosures.

- Remove two 6-32 screws from the top rear of the dynamometer enclosure.
- Slide the top cover straight back and remove.
- Remove the filter element by rotating the plastic frame inside the cabinet. It is unnecessary to remove the frame from the side plate.
- Wash the filter by holding it under a warm water tap. Shake off excess and re-install it following the above procedure in reverse.

If the filter element requires replacement it may be purchased from Magtrol , Inc. Part No. 7294 or, Howard Industries, Model 3-90-8099 Filter Assembly. The only other items possibly requiring replacement are the dynamometer shaft bearings. Unless the dynamometer bearings are subjected to severe high speed - high temperature operation, they should survive several thousand hours operation. If the bearings become noisy, they should be replaced immediately to avoid any possibility of seizure and subsequent damage to other members.

Replacing the shaft bearings requires partial disassembly of the dynamometer. Instructions are covered in the following paragraphs.

1.9 Disassembly:

Disassembly should be attempted by qualified personnel experienced in precision electro-mechanical instruments.

The extent of the disassembly is dependent upon the component requiring service. The following is a step by step procedure resulting in major disassembly for bearings or part replacement.

FOR MAGTROL MODELS HD-106 THRU HD-705

( FOR MODELS HD-800 AND HD-805 REFER TO PAGE 8A)

a. Remove all rear panel retaining screws.

b. Carefully slide the top cover off, and lay the rear panel down flat leaving all lead wires attached. This exposes the dynamometer electronic assemblies and photo-cell pick up.

c. Remove the pulse disc from the end of the shaft.

d. Un-solder the dynamometer brake lead wires from the two outside terminals of the photo-cell block.

e. Loosen (do not remove) the load cell clamping screw (top of load cell) two or three turns.

f. Lift the base plate from the front, and reaching under the base plate, remove the two screws retaining the front pillow block.

g. Resting the unit flat, grasp the front pillow block and simultaneously apply an upward force on the dynamometer shaft to relieve the weight; slide the pillow block and front panel assembly straight forward off the yoke.

h. Gently release the brake assembly and allow the unit to hang cantilevered off the rear upright. Remove the frontpillow block and plate assembly.

i. Reach to the rear of the brake assembly and grasp the load cell. Also grasp the brake assembly and with a twisting motion pull the brake assembly forward just free of the load cell. Do not lose the aluminum spacer washers.

j. Place the load cell on the top of the photo-cell block, (tape it down if necessary.) Do not pull excessively on the lead wires and do not touch or allow anything to touch the foil strain gages.

k. Feeding the brake lead wires (previously disconnected in step d) through the upright, remove the brake assembly straight forward and out.

l. Remove the three bearing cap retaining screws. Remove the bearing cap, which is an assembly of a steel member and a phenolic thermal insulator.

On the HD-705 a rear yoke is used instead of a bearing cap. This is attached to the case by two screws. When the yoke is slipped off, allow the lead wires to feed through the hole carefully so as not to snag.

m. Remove the front yoke by removing the two retaining screws.

n. With the proper snap ring pliers, carefully remove the snap ring on the shaft at the back of the brake. Do not spread the ring too wide.

Snap rings are not used on the HD-705. The rear rotor is retained by set screws in the hub. Remove both set screws completely.

o. Grasp the shaft at the rotor end and pull the rotor shaft out of the brake. On the HD-705 use a twisting action on each rotor, and the rear rotor will slide off the shaft. When re-assembling the HD-705 do not push the rotors together too tightly. Approximately .003" end play is desirable to permit thermal expansion. Also when re-assembling, be sure the set screws line up with the flats on the shaft and are tightly installed.

FOR MAGTROL MODELS HD - 800 AND 805

a. Loosen the four 5/16" cap head screws that mount the front pillow block to the base plate. Do not remove the screws, simply loosen them one or two turns.

b. From under the base plate locate and tap out the two dowel pins locating the front pillow block. Use a drift and mallet and tap the pins such that they fall free of the upright casting.

c. Lay the unit flat (normal position) and remove the four rear panel retaining screws. Reach inside the dynamometer housing and remove all four of the 1/4 - 20 cap screws that retain the housing to the base plate. The two front screws are difficult to see but are located at each front corner.

d. Lift the entire housing assembly straight up. The front panel is fixed to the front pillow block and must slide in each corner channel. When the housing is clear of the front panel, set it aside.

e. Remove the pulse disc from the end of the dynamometer shaft.

f. Unsolder the dynamometer brake lead wires from the two outside terminals of the photo-cell block.

g. Loosen (do not remove) the load cell clamping screw (top of load cell) four or five turns.

h. With wooden block or small jack standard, relieve the dynamometer brake weight from the carrier bearing in the front pillow block.

I. Remove the four 5/16" cap screws retaining the front pillow block casting, and remove the pillow block with the front plate attached.

j. Remove the load cell by sliding it off the rear support assembly. This must be done with care. The lead wires are still attached to the load cell. Grasp only the collar section of the load cell; do not touch the leaf portion or strain gages. Gently allow the load cell to rest on the photo cell pick up block and tape it down, so that it is secure and the lead wires are unstressed. Do not remove the pivot bearing stop assembly.

k. Disconnect the air line at the mounting block, from the brass fitting. Slide the brake assembly forward and free of the rear upright.

l. Remove the three bearing cap retaining screws. Remove the bearing cap, which is an assembly of a steel member and a phenolic thermal insulator.

On the HD-805 a rear yoke is used instead of a bearing cap. This is attached to the case by four screws. When the yoke is slipped off, allow the lead wires to feed through the hole carefully so as not to snag.

m. Remove the front yoke by removing the two retaining screws.

n. With the proper snap ring pliers , carefully remove the snap ring on the shaft at the back of the brake. Do not spread the ring too wide.

Snap rings are not used on the HD-805. The rear rotor is retained by set screws in the hub. Remove both set screws completely.

o. Grasp the shaft at the rotor end and pull the rotor shaft out of the brake. On the HD-805, the rear rotor will slide off the shaft. When re-assembling the HD-805 do not push the rotors together too tightly. Approximately .003" end play is desirable to permit thermal expansion. Also when re-assembling, be sure the set screws line up with the flats on the shaft and are tightly installed.

The shaft bearings may be removed from the brake assembly.

Further disassembly of the brake is not recommended since special jigs and fixtures are required.

Re-Assembly Procedures:

Follow the preceeding paragraphs in reverse and observe the following points:

- On the HD-800 models do not overtighten the button head screws that attach the bearing cap. Excessive pressure could crack the phenolic material , weakening the assembly.

- With the brake assembly re-installed in the upright, slip the load cell aluminum spacer washer over the bearing cap against the upright carrier bearing inner race. Install the load cell on the pilot diameter tightly against the spacer, such that the carrier bearing inner race is trapped and secure.

- Level the brake such that the front yoke is horizontal and tighten the load cell clamp screw.

- Resolder the brake lead wires on the two outside terminals of the photo-cell blocks. (no polarity).

The shaft bearings may be removed from the brake assembly.

Further disassembly of the brake is not recommended since special jigs and fixtures are required.

Re-assembly Procedures:

Follow the preceeding paragraphs in reverse, and observe the following points:

- On HD 106 thru HD 700 models do not overtighten the button head screws that attach the bearing cap. Excessive pressure could crack the phenolic material, weakening the assembly.

- With the brake assembly re-installed in the upright, slip the load cell aluminum spacer washer over the bearing cap against the upright carrier bearing inner race. Install the load cell on the pilot diameter tightly against the spacer, such that the carrier bearing inner race is trapped and secure.

- Level the brake such that the front yoke is horizontal and tighten the load cell clamp screw.

- Feed the brake lead wires through the upright 3/16" Dia. hole provided, and re-solder later. Do not pull the wires tight.

- It may be necessary to reset the mechanical "V" stops on some models. Refer to paragraph 1.10.2 Alignment.

- When installing the front pillow block, start the screws in by hand and before tightening, pull the pillow block forward for maximum clearance between the pivot bearings.

- Re-solder the brake lead wires on the two outside terminals of the photo-cell blocks. (No polarity).

1.10 Mechanical Alignment:

1.10.1 Load Cell Stop Bearings:

In order to provide a means for cancelling directional torque differences, (caused by a number of factors) the load cell pivot bearings are retained in a bushing locked in the upright by a set screw. Initially this is adjusted at the factory and no subsequent re-adjustment is anticipated. If the load cell should be replaced by a new one, then an adjustment of the pivot stop might be necessary.

Set up the calibration beam as outlined in paragraph 1.4.2. If the procedure shows an excessive directional error proceed as follows:

a. Remove the rear panel mounting screws.

b. Remove the top plate.

c. Holding the axial cooling fan from the inside, remove the four screws mounting the fan onto the side plate. Carefully lower the fan onto the base plate.

d. From the bottom of the base plate remove the four outside cap head screws that retain the housing onto the base plate.

e. Lift the housing carefully straight up and away.

f. On the right hand edge, (front view) of the rear upright is a set screw, back this set screw off approximately one turn.

g. Energize the dynamometer, (be careful of the fan blade!).

h. From the procedures outlined in paragraph 1.4.1 note the CW vs. CCW error. With a drift punch and mallet, tap gently on the top or bottom pivot bearing shaft in a manner to rotate the pivot support as follows:

If the torque is high CW, tap the bottom pivot shaft in. (Do not strike the bearing, and start out tapping lightly,) If the torque is highest CCW tap the top pivot shaft. By this manner remove 1/2 of the error only, since whatever is subtracted from one direction will automatically add to the other. Be sure to maintain the calibration beam horizontally, since this will be altered as the pivot rotates, however slightly.

i. After this alignment is satisfied, lock the bushing with the set screw, re-check, then re-assemble the housing and fan.

1.10.2 V Stop Adjustment:

The V stop is only a precaution against anyone applying excessive hand torsional force to the brake assembly when exposed. (Housing removed.)

Adjust the stop as follows:

a. A hole is provided at the rear of the upright to expose the moving member of the V stop. Use an allen wrench to loosen the stop. Do not remove it.

b. The stationary portion of the stop is secured by two screws located at the front of the upright. Loosen this member and push it toward the center. While maintaining pressure, lock down the rotating member tightly.

c. Back off the stationary member all the way by pulling it away from the center line of the unit. Lock it in place.

NOTE: To center the inside V stop it may be necessary to loosen the load cell clamp and rotate the entire assembly. Some free play exists between the load cell pivot bearings so it is necessary to average the centering adjustment.

## 2. MODEL 4605

### 2.1 Circuit Description:

The electronics are in two sections. Torque and speed.

#### 2.1.1 Torque Transducing:

The stator assembly of the dynamometer is restricted from motion by the load cell. The load cell consists of a strain member with foil type gages bonded to it, forming a basic bridge network. In addition to the strain gages there is a temperature sensing element which compensates the bridge for apparent strain and gage factor errors. Apparent strain appears as a zero drift and must be individually compensated on each load cell. All the interconnections and component installations are contained on the circuit board attached to the load cell. Adjustment of the zero drift trim potentiometer on the load cell is covered under electrical alignment paragraph 3.2.1. Referring to the dynamometer schematic diagram; current is applied to the bridge through the red and white wires interconnecting the amplifier-power supply P.C.Bd. No. 7342, to the load cell assembly. When the bridge is unbalanced a voltage is produced at the green and blue lines. The magnitude of this voltage is approximately .012 VDC for full scale. The green wire connects directly into the (-) input side of the chopper stabilized operational amplifier. The blue line is common and connects to the "O" supply line along with the (+) common input of the amplifier. The current supply for the load cell is isolated from the common line and must remain "floating". Calibration of the system is accomplished by adjusting the load cell current with the variable resistor marked CALIBRATION. The ZERO adjust potentiometer unbalances the bridge, compensating for any combined inherent unbalance of the individual strain gages, operational amplifier, and readout meter.

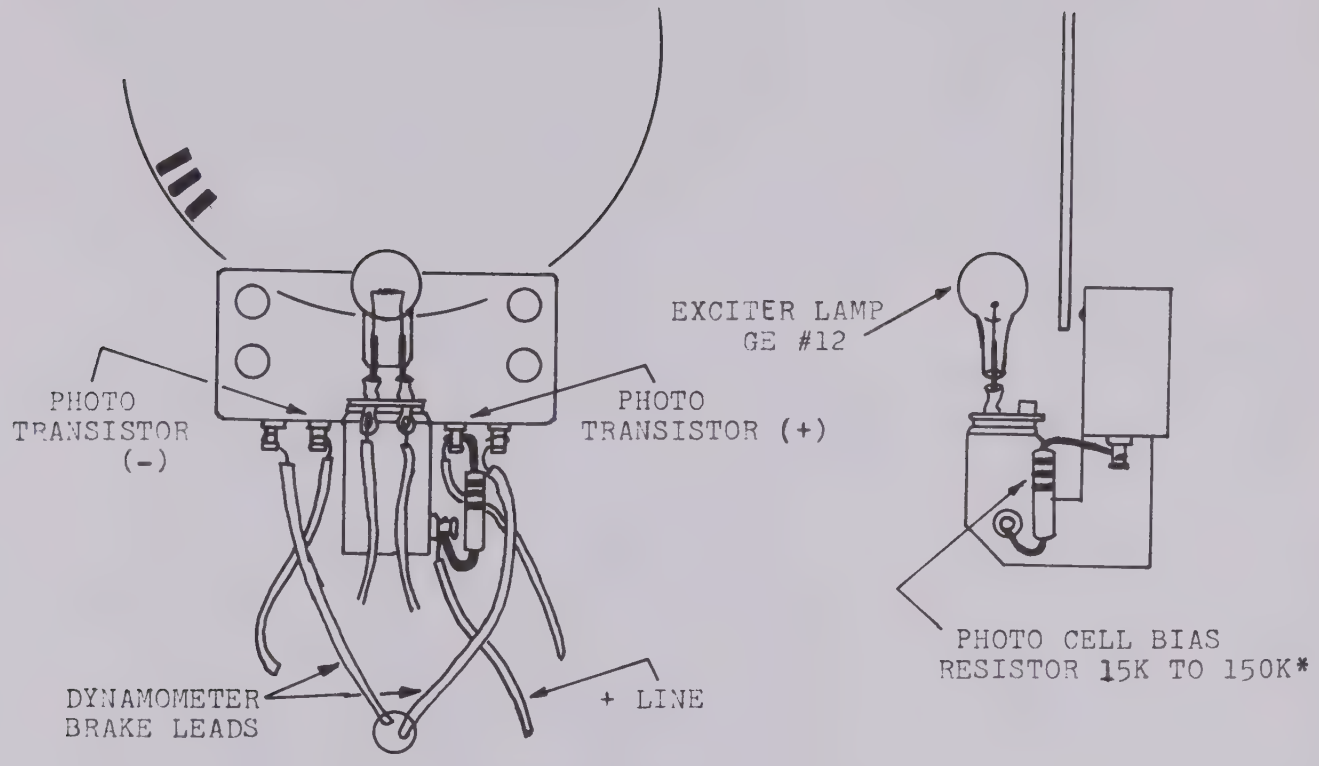
The load cell amplifier requires + 15 VDC and - 15 VDC. These power supplies are contained on the amplifier circuit board and consist of Zener diode pre-regulators and integrated circuit precision regulated power supplies. Two trim potentiometers are located on the P.C.Bd to adjust the supply voltages. The range of adjustment is approximately 12 to 18 volts on each (+) and (-) supply section. The voltage input to the dynamometer is in three isolated sections located on pins 1 through 6 of the 14 pin dynamometer connector. This is decreased by the pre-regulator to 20 VDC and further decreased to a highly stable 15 VDC by the precision regulator.

2.1.2 Speed Transducing:

The tachometer pick up is a block consisting of a lamp, photo-cell, resistor and terminals. Referring to Figure 5, this assembly is identified by Magtrol Part No. 7116, including the pulse disc mounted on the dynamometer shaft. The photo-cell block must be located to place the pulse disc close to the photo-cell window in the approximate center of the 60 bit outside track. The printed side of the disc should be toward the photo-cell for best definition. Since an operating tolerance exists with each photo-cell, the cell current control resistor is also mounted on the block allowing the electronic circuitry to be universal. The disc must clear the photo-cell with all axial tolerance taken up in the direction of contact. (Pulling out on the dynamometer shaft, motor end.) It should not be spaced away more than .040 inches. Referring to the dynamometer schematic, a regulated potential of +16 VDC is applied to pin 11 at the input connector to the current control resistor mounted on the photo-cell block. The photo diode is in series and is the ground return for the applied voltage. As light causes the cell to conduct (low resistance), the voltage on the signal line and connector pin 10, is low. Alternately, as light is cut off, the signal voltage rises.

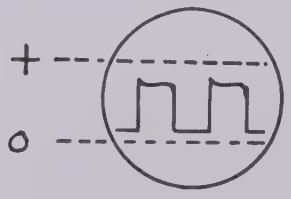
Refer to the control cabinet (Model 4605) schematic, and the schematic for Model 4602 B PC. Bd No. 7500. As the disc interrupts light the resulting voltage is applied to the first amplifier stage of Pc.Bd. No. 7500. (Follow pin 10 of 14 pins pin connector to terminal 9 of the PC. Bd.7500. The PC.Bd. No. 7500 is a complete (less the power transformer) frequency counter. The signal or frequency is applied to pin No. 9 imposing a voltage onto the base of the first amplifier transistor. The output is coupled through 1 mfd. to a dual nor gate. One-half of the nor gate provides a sharp pulse to the first counter No. 7490. The second half of the nor gate provides a buffered frequency output to operate special power supplies 4609-4634. The output of the first counter is a replica $\div$ 10 of the input, and is applied to the second counter. This signal process is repeated into succeeding counters to acquire the four digits. Each counter output is binary coded and applied to the No. 7475 quad latch. The output of each quad latch is applied to the No. 7441 decoder driver which in turn operates the*Nixie tube readouts. In order to relate the frequence input to RPM a time base is necessary. This is accomplished by taking each half wave cycle (as referenced to (-) common) and filtering this information;

* Burroughs Trade Mark




* TO ESTABLISH CORRECT VALUE:

1. CONNECT OSCILLOSCOPE ACROSS PHOTO-TRANSISTOR (+) AND (-)
2. ROTATE DYNAMOMETER SHAFT AT OR NEAR MAXIMUM R.P.M.
3. VARY RESISTANCE VALUE

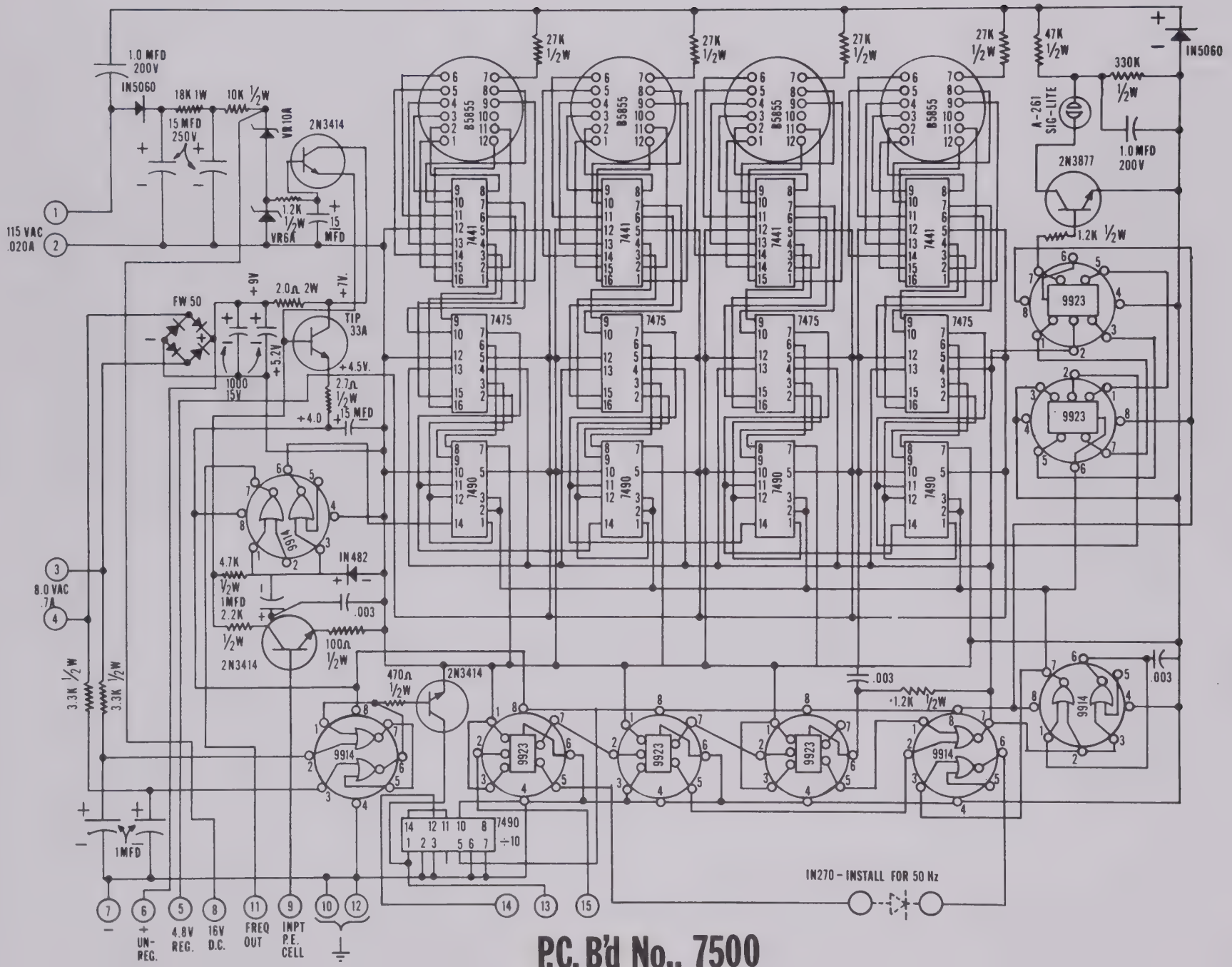



FOR BEST SQUARE WAVE FORM.

NOTE: DO NOT SHORT, or use RESISTANCE LESS THAN 2.7K

TACHOMETER GENERATOR
PART NO. 7116

FIGURE 5.


1.0 MFD 200V
IN5060
18K 1W
10K ½W
15 MFD 250V
VR10A
2N3414
1.2K ½W
VR6A
15 MFD
115 VAC .020A
FW 50
+9V
2.0Ω 2W
+7V.
TIP 33A
+5.2V
+4.5V.
1000 15V
2.7Ω ½W
+4.0
15 MFD
9914
IN482
4.7K ½W
1MFD
2.2K ½W
2N3414
.003
100Ω ½W
8.0 VAC .7A
3.3K ½W
3.3K ½W
470Ω ½W
2N3414
1MFD
27K ½W
B5855
7441
7475
7490
9923
9914
47K ½W
330K ½W
A-261 SIG-LITE
2N3877
1.0 MFD 200V
1.2K ½W
.003
1.2K ½W
IN5060
7490 ÷10
IN270 – INSTALL FOR 50 Hz
7 – 6 + UN-REG. 5 4.8V REG. 8 16V D.C. 11 FREQ OUT 9 INPT P.E. CELL 10 12 14 13 15

# P.C. B'd No., 7500

and applying it to a RS "flip flop" and count down circuit. The binary information is decoded by No. 9914 nor gates and applied to the counters for reset and the quad latches as a clock signal to read the stored count. A selector switch on the front panel switches a ÷ 10 element in or out. This provides for the count period of 1. second or .1 second resulting in an RPM indication of ± 1 RPM or ± 10 RPM (resolution).

2.1.3 50 Hz Conversion:

If speed indication from a 50 cycle power source is required, it becomes necessary to alter the counter time base to provide the 1.0 or ,1 second count period from an input of 50 Hz instead of 60 Hz.

This is accomplished by installing any good quality low forward drop (Germanium) diode (type IN270 or equivalent) on the PC. Bd. No. 7500. Two circuit spots are provided for this on the rear edge of the board. Observe polarity as shown on the board.

## 3. ALIGNMENT ELECTRICAL:

### 3.1 Weston Digital Voltmeter:

If the readout meter is off-set ie; a reading above or below 000 with a true input at zero potential, then it will not be possible to switch the CW-CCW shaft direction switch without a zero error. The condition is confused by the ability to adjust the zero torque signal, plus or minus, with the zero potentiometer on the rear of the dynamometer cabinet. This control may in effect apply a potential sufficient to off-set a meter error, thus indicating true zero. It is perfectly satisfactory to operate the equipment in this manner, except that if the shaft direction switch is changed. the meter would indicate above or below zero, by an amount exactly double the meter fixed off-set error.

If the normal use of the equipment does not involve frequent shaft direction changes, the following alignment instructions may not be necessary. On the other hand, the following is offered for those test conditions requiring frequent shaft direction changes and/or in the event of excessive readout meter zero drift.

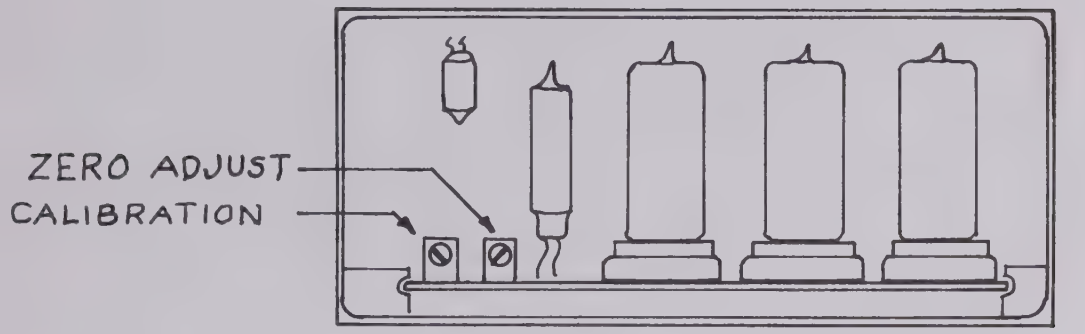
3.1.1 Weston Meter Zero Alignment:

1. Disconnect the 14 pin dynamometer plug and all other plugs and connections on the rear panel of the 4605.

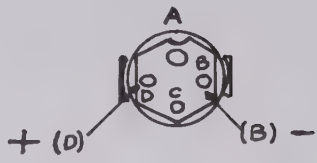
2. Remove the top cover of the 4605 readout (two screws in rear).

3. Remove the left hand mounting screw retaining the plastic meter mask only.

4. Reach behind the front panel and raise the mask to expose the two screwdriver adjusting potentiometers on the left hand side of the meter. Refer to Figure 3.




TORQUE




USE .040 DIA. (APROX.) WIRE FOR PIN CONN.

FIGURE 3

5. Turn on the equipment and allow at least 1/2 hour warm up.

6. Connect a jumper wire between the torque signal output plug pins B and D. Rotate the right hand zero adjust potentiometer with a screwdriver until the meter indicates 000 ± 1 digit.

7. Remove the jumper wire and connect a standard 1.000 volt source to + on pin D and - on pin B on the torque output socket located on the rear panel. With the full scale voltage applied, rotate the left hand full scale adjust potentiometer until the meter indicates 1000 ± 1 digit.

8. Repeat steps 6 and 7 as necessary until proper adjustment is achieved, but finish the adjustment procedure with step 6. The precision with which the 1.000 volt calibration is accomplished is not critical, since the real accuracy is torque calibration outlined in paragraph 1.4.1. However, in the event the equipment is used with the model 4634 and associated X-Y recording equipment, it is preferable that the torque output voltage be calibrated for proper scaling.

## 3.2 Dynamometer:

Three circuit board trim pots are located inside the back panel of the dynamometer. These are initially set up at the factory and no adjustment should be necessary unless a major part is replaced, or the zero reading and/or calibration cannot be maintained.

### 3.2.1 Load Cell:

A trim pot is located on the load cell mechanical assembly. The purpose of this adjustment is to balance out temperature related zero drift. The adjustment must be done under controlled conditions. Indescriminate rotation of the control could result in instability of the zero torque reading. The following procedure is offered as an adjusting method with a minimum of instrumentation.

1. Stabilize the dynamometer at room temperature. If the dynamometer is warm (from motor testing) a cooling off period of at least four hours is required. The cooling fan should be left running. The torque readout should be ON for at least 1/2 hour prior to the following procedure.

2. Slide off the top cover. Rotate the trim pot 25 turns CW (use a "flag" on the screwdriver shaft for turns counting.) then rotate the pot exactly 9 1/2 turns CCW.

3. Adjust the rear panel ZERO TORQUE for zero indication. Note the position of the CW, CCW shaft direction switch on the 4605 front panel.

4. The strain gage is now set for virtually no compensation. It is necessary to heat the dynamometer and promote drift in order to apply a correction. Connect a motor with enough power to heat the dynamometer. It may be necessary to refer to the power dissipation curves for correct values. Select a combination of torque and speed that will produce approximately the maximum rated wattage and apply this for one hour. Be sure the top cover is closed. It is not desirable to produce high thermal gradients by excessive power, but rather a slow stabilizing application of power.

5. After the dynamometer is hot, stop the motor and disconnect the shafts. Do Not turn off the dynamometer cooling. Slide back the top cover, and work quickly. Be sure that the CW, CCW shaft direction switch is in the same position as in paragraph 3 above.

6. Observe the torque reading. If it is zero or within .15% of full scale, no further adjustment is indicated. If the zero error is enough to compensate, (above .15% F.S.) adjust the trim pot as many turns as required to obtain zero, followed by additional rotation in the same direction to produce a reading of 1/2 of the original error before correction. This reading would be on the other side of zero. (-). In making the adjustment it will be necessary to lift the screwdriver off the pot to observe a reading since the downward force of the tool is enough to cause a small reading.

   Example: After step 5, the error on the digital readout is 005. oz.in. Turning the pot CW results in a reading of 006. - wrong direction - rotate CCW one turn, remove screwdriver; error is 003., repeat CCW until a reading of -.002 (Flashing 1997-1998).

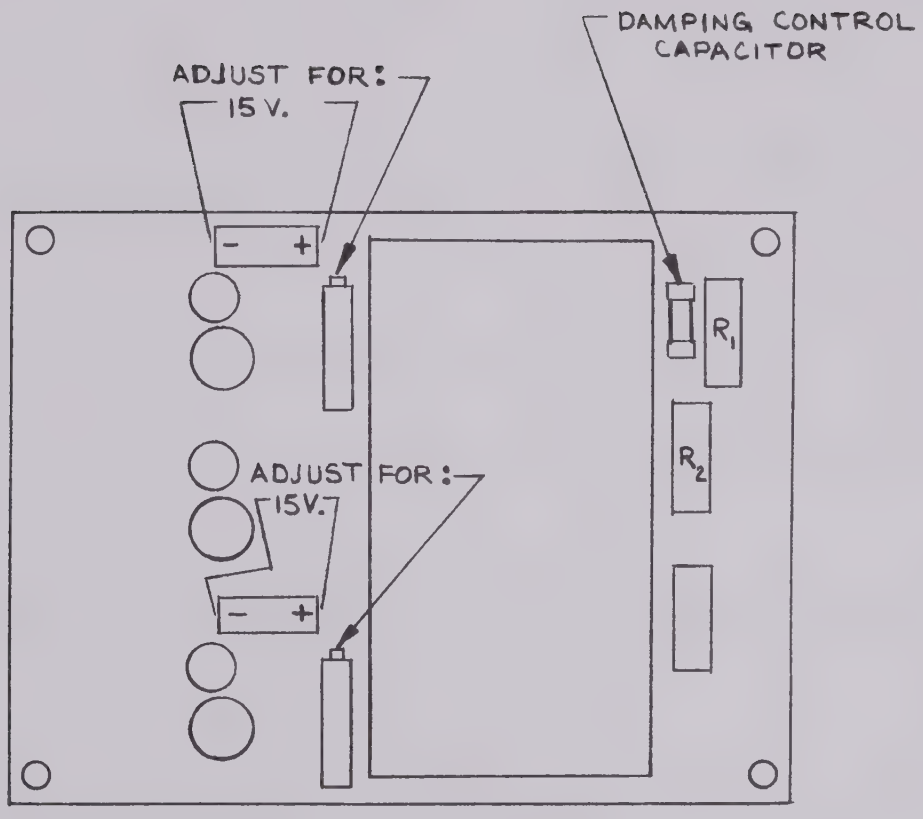
7. Reset the zero torque pot on the rear panel for true zero, and the adjustment is complete.

3.2.2 Amplifier Power Supplies:

Both trim pots are on the amplifier circuit board mounted on the rear panel of the dynamometer cabinet. Refer to Figure 4 and measure the voltages across the two 2.mfd. capacitors as shown. The voltages should be 15 + .5 volts, and within .02 volts of each other. Adjust the respective trim pot as required.

## 4. DAMPING:

It may be desirable to reduce the torque response time. With the use of X-Y recorders or strip chart recorders it might be desirable to limit the response of the system to something less than the natural frequency of the brake-load cell combination. This may be accomplished by increasing the value of the damping (or feed-back) capacitor. The torque amplifier section is mounted on the rear panel, inside the dynamometer. Remove the four rear panel retaining screws. Slide the top cover back a few inches. Figure 4 indicates the location of the damping capacitor. Increasing this capacitor to .1 mfd or 1. mfd will likely provide




$R_1$ & $R_2$ - GAIN CONTROL RESISTORS

$$\text{AMPLIFIER GAIN} = \frac{R_1}{R_2}$$

FIG. 4 OP-AMP P.C. BOARD — #7342

the desired effect. Be sure to check and re-adjust calibration, if necessary, referring to paragraph 1.4.2. Use only high quality mylar or poly-carbonate capacitors. Do Not use tantalum or electrolytics for this application.

## 5. MODEL 4609 POWER SUPPLY

### 5.1 General Description:

This unit is the same size as the 4605 and interconnects with the 4605 and the respective dynamometer unit. It controls the dynamometer brake directly, obtaining the speed signal from the 4605 or 4603 digital readout.

#### 5.1.1 Set Up:

1. Be sure the 4609 is turned off, (right hand ON-OFF switch) plug the unit into a standard 117 volt 60 Hz outlet.

2. Connect the 2 pin dynamometer cord set into the 2 pin socket on the back of the dynamometer, and the other end into the matching 2 pin receptical on the 4609.

3. Connect the accessory 6 pin - phone jack cord set between the 4605 or 4603 readout, and the 4609 power supply; 6 pin end into the 4609, and the phone jack end into the receptical marked "4609 - 4602 Speed" on the digital indicator.

#### 5.1.2 Operation:

1. Connect the motor as outlined in the dynamometer section.

2. Set the DYNAMOMETER BRAKE SWITCH off.

3. Switch the right hand main power switch ON.

4. Set the SPEED CONTROL DAMPING switch to No. 2 position.

5. Set the MAXIMUM MOTOR SPEED switch to the first position above the anticipated free run motor speed. ie., some 2 pole 60 Hz induction motors operate at a free run speed of 3575 to 3585. Therefore set the switch for 4000 RPM.

6. Be sure that both STABILIZED CONTROL potentiometers are fully CCW.

7. Start the motor, or in the event the motor is already running the DYNAMOMETER BRAKE light should be out - if it is not, re-examine paragraph 5 above.

8. Switch the DYNAMOMETER BRAKE switch on.

9. Rotate the SPEED Potentionmeter slowly CW. It is a three turn potentionmeter and there will be a "dead" zone, requiring 1/2 to 3/4 turns before any application of torque. It will be possible to operate the motor down to approximately 100 RPM. By advancing the SPEED control full CW full torque will be applied, and the locked rotor torque will be indicated by the 4605. Restore the motor to free run by rapidly rotating the control CCW; at full CCW always turn the DYNAMOMETER BRAKE swith OFF for standby.

## 5.2 Control Functions:

### 5.2.1 Speed Control Damping:

This switch controls the rate feedback in the servo amplifier. At position 1 this feedback is small and is approximately doubled with each successive step to position 4. Some rate control is essential for system stability On the underside of the unit there is a hole in the bottom plate, which permits accessibility to the stability control. This control sets the over-all level of the damping selector. Too much or too little will result in system instability and oscillation. It may become necessary to adjust this control, when converting from a small dynamometer to a very large unit. (Generally oscillation occurs only in the unstable portion of a torque speed curve). With the DAMPING selector in position 1, rotate the control in a CCW direction slowly. The frequency of oscillation will increase until it damps out completely. If the end of the pot is reached before this occurs, set the DAMPING selector on 2 and repeat the procedure, starting with the control almost full CW.

### 5.2.2 Stabilized Controls:

The dynamometer may be operated with either the speed or torque adjustable and stabilized. Each control is identified for this function.

### 5.2.3 Dynamometer Brake ON-OFF:

The dynamometer brake may be switched ON or OFF. When the brake is OFF, the indicator light is still maintained, such that if the power supply is calling for torque a visual indication of this fact is present. It is safe to switch the brake ON only if the indicator is out.

# 6. MODEL 4772 PLUG IN SECTION - X - Y RECORDING

## 6.1 General Description:

The 4772 is a plug in section suitable for any Magtrol model 4609 or 4634 power supply manufactured since 1965. This unit provides analog outputs suitable for X-Y recorder operation. In addition, it performs an analog computing function to cancel the effects of motor and dynamometer inertia. This is accomplished by differentiating the speed signal with an operational amplifier. The differentiated signal characteristic is a voltage output proportional only to the rate of change of speed. When adjusted to the proper level this signal is also analogous to the total system inertia. It is automatically added or subtracted from the torque signal, dependent upon acceleration or deceleration. Since the speed signal inherently has no directional sense whereas the torque signal does, it is essential that the proper signal polarity relationship be maintained. This is accomplished by simply making sure that the Shaft Direction Switch on the model 4605 Digital readout is properly set (CW or CCW) to the actual dynamometer shaft direction. In the event the shaft direction is improperly set, the inertial cancellation signal would add when it should subtract, etc. In order to eliminate the possibility of the system being set up in this manner a red light automatically detects any signal relationship polarity error and flashes "on" accordingly.

### 6.1.1 Installation:

If the plug in section No. 4772 is already installed in the 4609 power supply (as in new equipment) proceed to paragraph 6.1.2.

To install the plug in section:

1. Remove the cover plates on the front and rear of the 4609. (4 Screws each) Be sure the unit is turned off.

2. From the front, feed the four pin miniature connectors inside the power supply and slip in the 4772 unit in about 2 or 3 inches. Reach in around through the rear panel cut out, and plug in the connector into the receptical on the right hand side of the chassis (right hand, as viewed from the front.)

3. Slide the 4772 unit into the 4609 cabinet carefully guiding the assembly front and rear until it mounts with the front plate flush on the front panel. The rear plate will be just inside the rear panel cut-out and slightly protruding.

4. Install the four front panel button head screws, but do not tighten any until all four are installed. Tighten the screws just secure - do not over tighten.

6.1.2 Set up:

A four pin connector cord set is provided to connect the 4605 torque signal output into the rear panel of the 4772 plug-in section.

Two banana jack cord sets are provided to connect the torque out-put to the X or Y axis of the X-Y recorder, and the speed output to the other axis. A ground jack is available to common ground the X-Y recorder to the 4609 - 4772 chassis. Do not ground any of the Speed or Torque outputs.

If the recorder is equipped with a ground or polarized plug, as is the 4609, the ground interconnection between the two units is automatic.

Two 1 C.P.S. filters are provided for signal conditioning where necessary. Always install the filters at the 4772 rear output, red (+) side to the red (+) terminal.

6.1.3 Calibration:

Due to the almost infinite variety torque and speed ranges of interest with this type of equipment, absolute analog outputs of volts per unit of torque and/or speed is not feasible. Approximate values are 1/2 of the total digital read-out of torque in millivolts.

For Example:

20.2 oz. in. = 202 millivolts 2 = .101 volts

or

202 oz. in. = .101 volts

or, on larger dynamometers

20.2 lb. in. again, is equal to 202 millivolts 2 = .101 volts.

Speed:

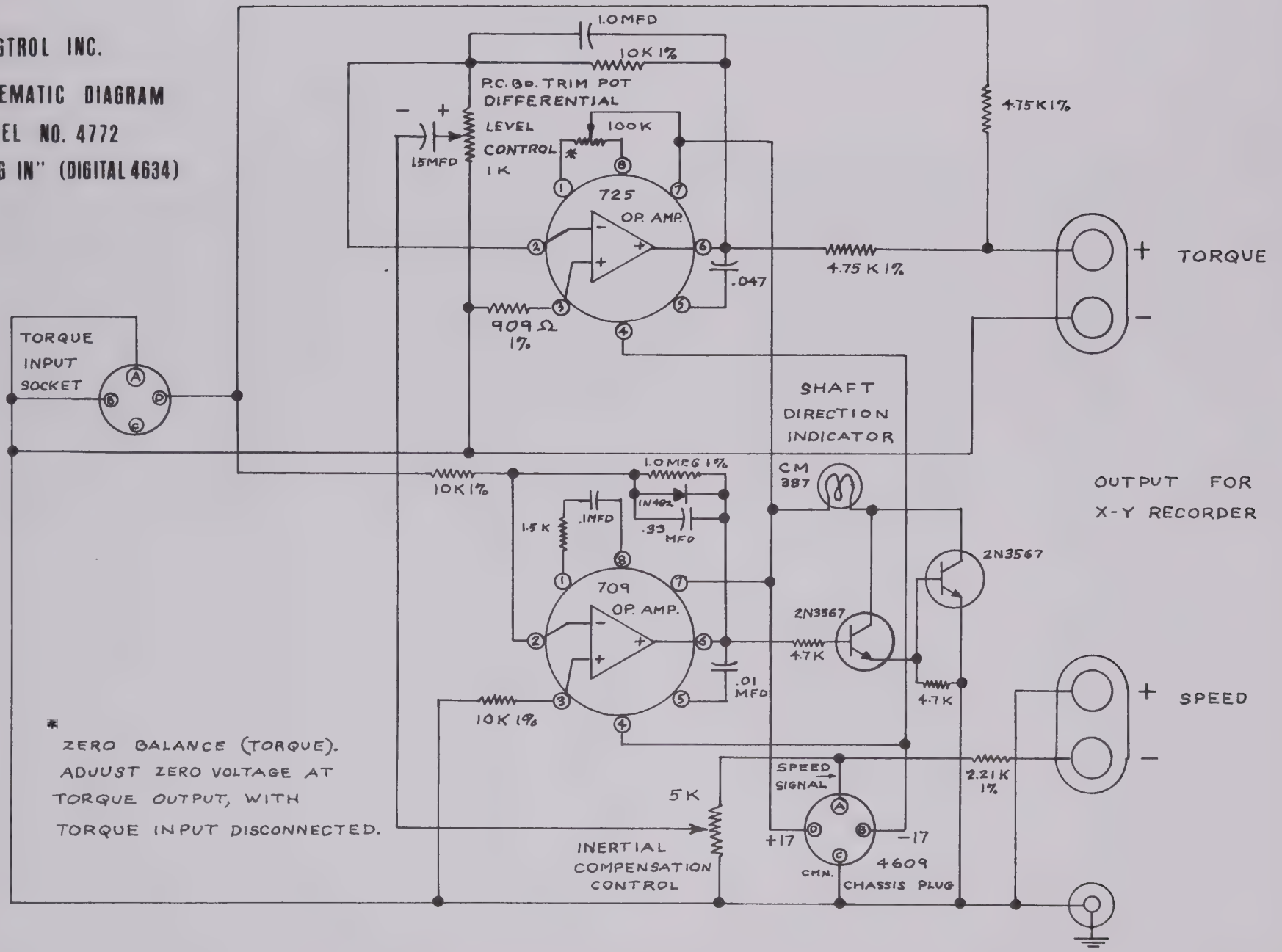
Each setting of the "Maximum motor speed" switch is equal to approximately 6.0 volts - ie .2000 RPM will produce approximately 6 volts at the 2000 RPM setting or 3 volts on the 4000 RPM setting.

MAGTROL INC.

SCHEMATIC DIAGRAM

MODEL NO. 4772

PLUG IN" (DIGITAL 4634)



6.1.4 Calibration procedure:

The 4605 digital readout and the dynamometer, as a system should be accurate as outlined as in section 1.4. The 4772 and X - Y recorder will not have any calibration influence (back) to this system.

Speed:

The simplest method to calibrate the recorder on the speed axis is to install a motor of a known speed. Starting with zero speed (motor off) oscillate the coupling by hand until the digital torque indicator reads zero. Set the recorder pen to the zero ordinates selected on the graph paper, both speed and torque. Turn on the motor, and set the calibration on the X-Y recorder, using the vernier and input range selector to scale the speed readout to a logical deflection of the X - Y recorder pen. Never adjust the zero control on the recorder to obtain a calibration, since that will only shift the scale and does not calibrate.

Torque:

Two methods may be used:

1. Perform the calibration procedure as outlined in paragraph 1.4.2 with a beam and dead weight. Scale the X-Y recorder torque ordinate to a calibrated value equal to the beam length times the weight.

2. An alternate and usually faster method is to calibrate the recorder by the same method used for the speed above. Greater stability will be realized if the "Torque" control is used instead of "Speed" control on the 4609. Simply establish a value of torque on the digital readout, and scale the recorder accordingly.

6.2 Control Functions:

6.2.1 Rear Panel Zero Balance:

This control corrects the offset error of the differentiating operational amplifier. The need for adjustment is indicated by a slight output to the X-Y recorder when the digital torque indication shows zero.

To adjust the offset:

1. Disconnect the 4 pin torque output from the 4605 - 4603.

2. Increase the sensitivity of the X-Y recorder, torque axis to 1 MV per inch.

3. Short the torque output at the jack on the 4772 "Torque". Set the recorder at a zero reference.

4. Remove the short; if the pen shifts plus or minus adjust the "Zero Balance" to re-establish the point obtained with the output shorted.

6.2.2. Inertial Cancellation Set Up:

With the test motor attached, the system calibrated and prepared to produce accurate torque speed curves, be sure the "inertial error compensation" control is "off".

1. Apply a load with the "Speed " control of the 4609; out on the torque speed curve where there is a proportunately larger decrease in speed to a change in torque.

2. If the "Speed" control is moved slowly C.W. a few degrees, then slowly CCW back to the original point a loop will be drawn, and the curve will not re-trace.

3. Rotate the "inertial compensation control" in a C.W. direction slowly, a few degrees. The torque axis on the recorder will shift (plus) then return to the stationary point.

4. Re-draw the loop with the "Speed" control on the 4609. It will be slightly narrower.

5. Repeat 3 above a few more degrees, then repeat 4 above.

Continue the above procedure until the line retraces up and down as the speed is changed. At this point the control is properly set. Figure 5 is a diagram approximating the traces.

6.3 Operation:

It is essential when X-Y recording motor performance that the curve not be obtained too rapidly. Once the recording rate exceeds the combined responses of the frequency to voltage conversion, and the X-Y recorder response time, accuracy deteriorates rapidly. As a general rule, a decrease in speed of no greater than 2 seconds per inch of speed axis travel, as an average rate, is acceptable.

When drawing a curve with the X-Y recorder, it is best to vary the rate of speed change to maintain a reasonable uniform pen travel. For example, on a synchronous motor, there would be a very large torque change with no decrease in speed whatever. Then, once pulled out of synchronization; the characteristic exactly reverses. In drawing this curve one should initially rotate the speed "control" very slowly, then more rapidly once the motor is pulled from synch. Although a synchronous motor represents an extreme example, the procedure is essentially correct with all types of motors.

Of course, if the performance curve is drawn too slowly, excessive temperature rise in the motor may result. This promotes I.R. loses which deteriorate performance.

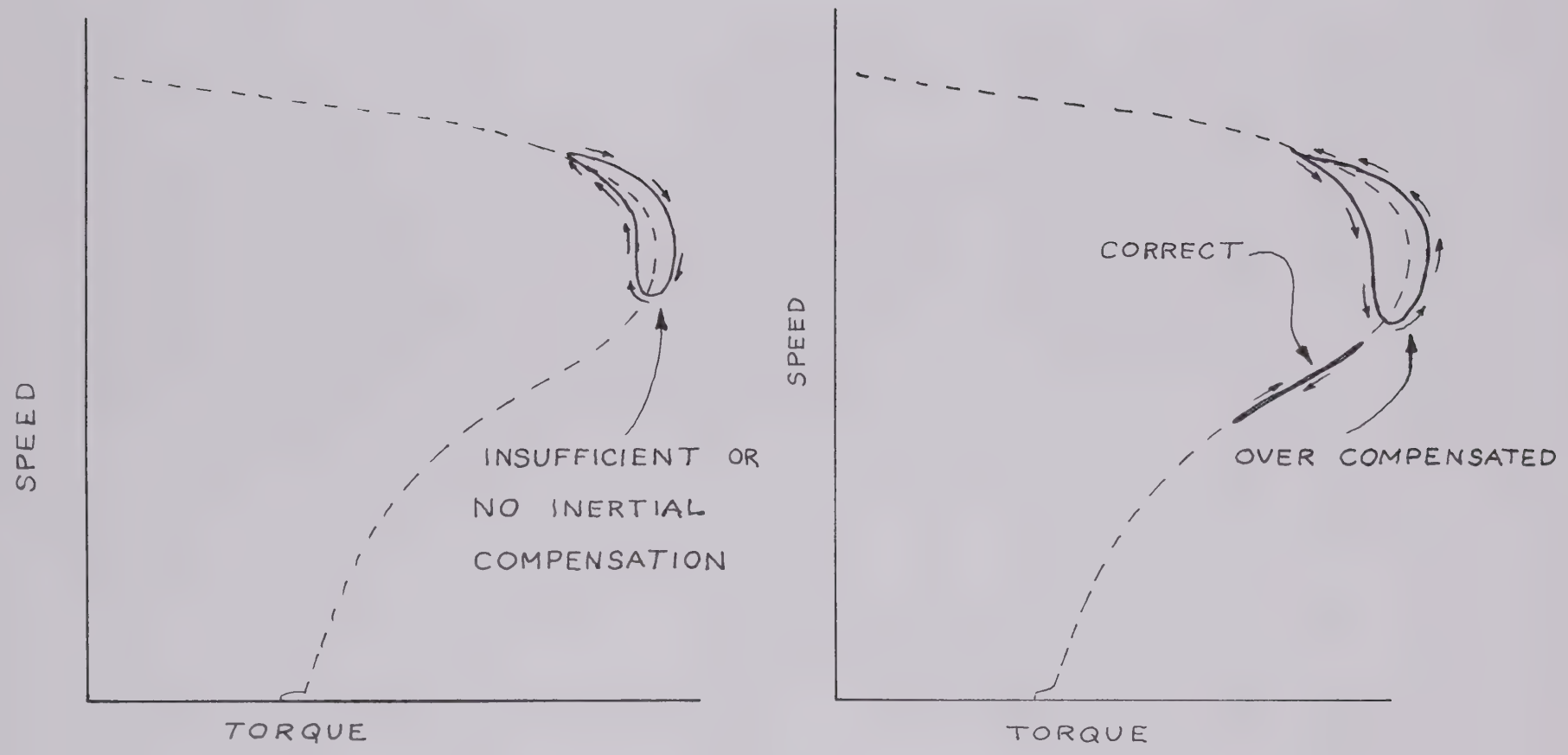

SPEED
TORQUE
INSUFFICIENT OR
NO INERTIAL
COMPENSATION
SPEED
CORRECT
OVER COMPENSATED
TORQUE

FIG. 5

The following is offered as an approach to obtain optimum performance. Using either the test motor or one that is similar.

1. Switch the brake switch off. Set the Damping selector on position 2. After the brake light extinguishes, switch the brake "on".

2. Apply some load with the speed control potentiometer. When the speed stabilizes drop the recorder pen, but immediately raise it again.

3. Rotate the control another increment CW and repeat the pen dropping procedure.

4. By this method, establish nearly a full performance curve with points obtained statically. Each point represents an accurate torque speed value without the effects of system response or inertia. As in (1) above switch to "Damping" position 3. Sweep the entire curve several times experimentally and establish a recording rate procedure which most nearly duplicates the point to point character.

Note: The output of electric motors is generally significantly effected by internal temperature. Therefore, do not be surprised if when drawing repeated curves the performance output successively decreases.

This procedure will also establish if the "Inertial Cancellation" control is set properly. When drawing the final performance curve of the test motor be sure and consider the preconditioning criterion. (Performance hot or cold) Often this is a philosophical problem relating to the deg ee of optimism to be applied to the performance data. In any event, consistency in test procedure is essential for sound engineering value.

## 7. MODEL 4603 TORQUE INDICATOR

### 7.1 General Description:

The Model 4603 is essentially identical to the Model 4605 except that the speed readout section is omitted. This option is made available to cover the following special situations:

a. Where existing Magtrol equipment has speed reading capability and redundancy is unnecessary .

b. Where speed indication is not a factor in test requirements.

c. Where other commercially available frequency counters are to be utilized.

#### 7.1.1 Speed Output

All Magtrol digital dynamometers are equipped with a shaft encoder for speed transducing. The Model 4603 contains the necessary electronics to excite this assembly and provide a frequency output proportional to speed, of 60 Bits per shaft revolution. Therefore the 4603 reduces to two independent sections.

### 7.2 Torque Transducing

This section is identical to that utilized in the Model 4605. Therefore refer to section 2.1.1.

### 7.3 Speed Transducing:

The tachometer pick up is a block consisting of a lamp, photo-cell, resistor and terminals. Referring to Figure 5, the assembly is identified by Magtrol Part No. 7116, including the pulse disc mounted on the dynamometer shaft. The photo-cell block must be located to place the pulse disc close to the photo-cell window in the approximate center of the 60 bit outside track. The printed side of the disc should be toward the photo-cell for best definition. Since an operating tolerance exists with each photo-cell, the cell current control resistor is also mounted on the block allowing the electronic circuitry to be universal. The disc must clear the photo-cell with all axial tolerance taken up in the direction of contact. (Pulling out on the dynamometer shaft, motor end.) It should not be spaced away more than .040 inches. Referring to the dynamometer schematic, a regulated potential of + 16 VDC is applied to pin 11 at the input connector to the current control resistor mounted on the photo-cell block. The photo diode is in series and is the ground return for the applied voltage. As light causes the cell to conduct (low resistance), the voltage on the signal line and connector pin 10, is low. Alternately, as light is cut off, the signal voltage rises.

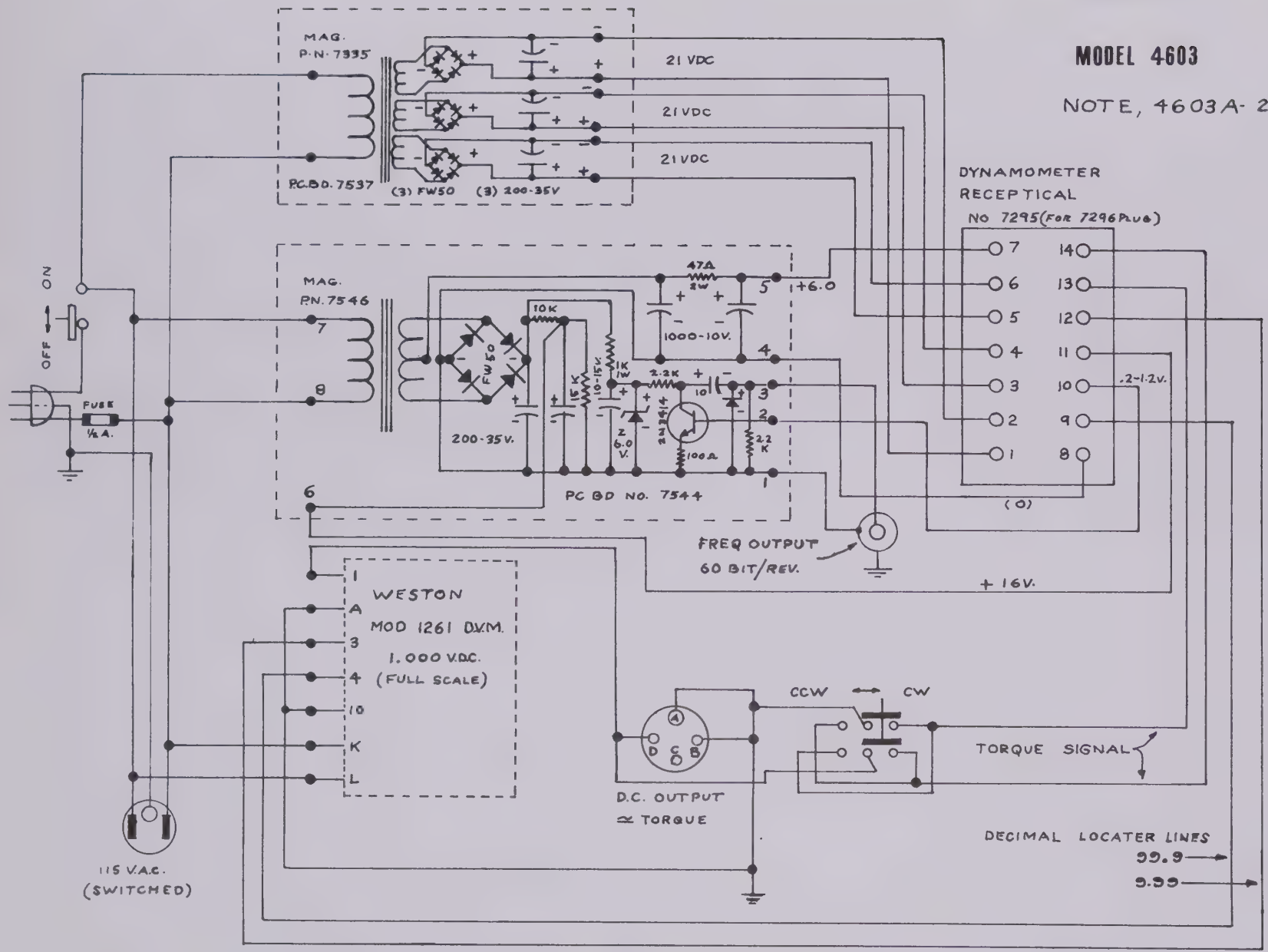
7.3.1 Circuit Description:

Refer to the Model 4603 schematic. As the disc interrupts light, the resulting electrical pulses are applied through pin No. 10 of the dynamometer receptical. This point is wired to pad 2 of the P.C. Bd no. 7544 installed on the back panel of the unit. The electrical signal is amplified to a sharp D.C. pulse train suitable for application to the Magtrol Model 4602 or 4609. The P.C. Bd. no. 7544 is a complete electronic package providing all necessary D.C. power to operate the Part No. 7116 shaft encoder installed in the dynamometer. The pulse train output is available at the miniature phone jack on the rear panel of the 4603. It is identified as "Output for 4609-4602 Speed".

# MAGTROL, INC.

## MODEL 4603

NOTE, 4603A- 220V. 50 Hz

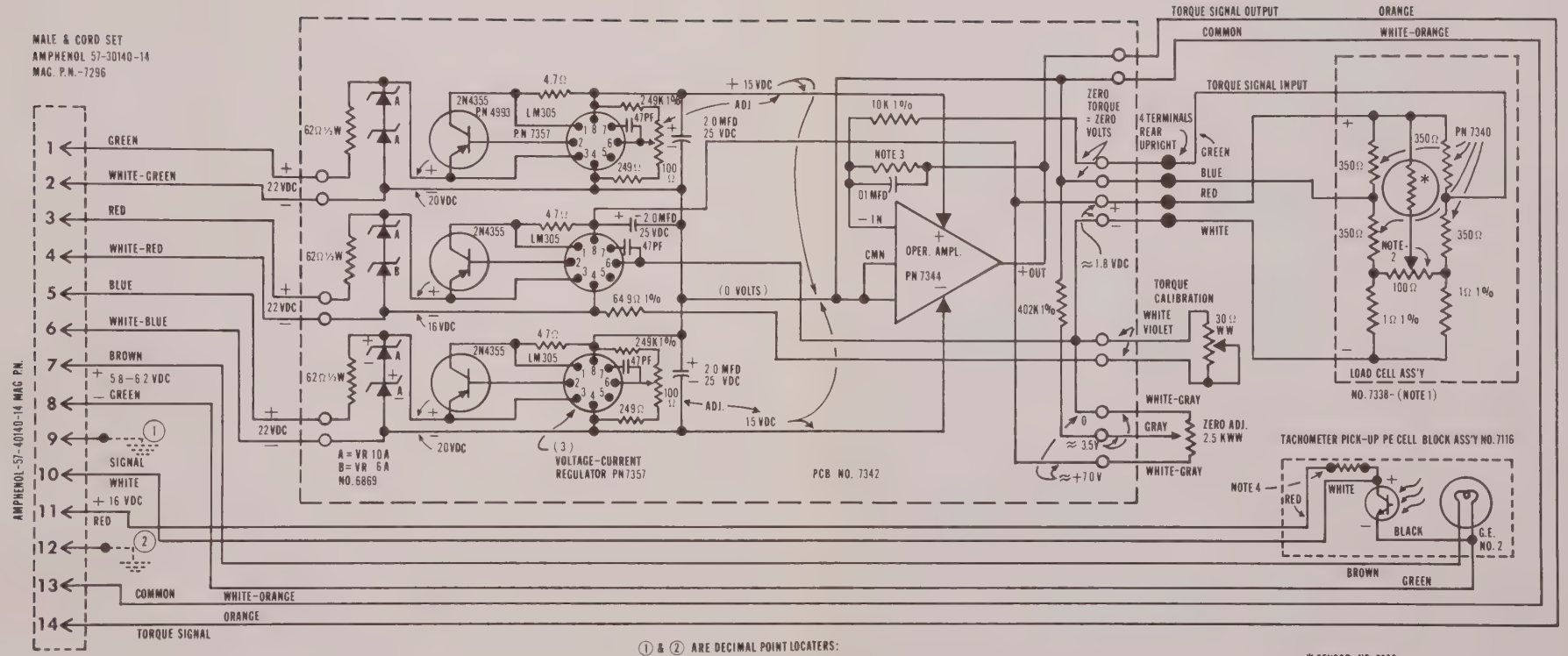


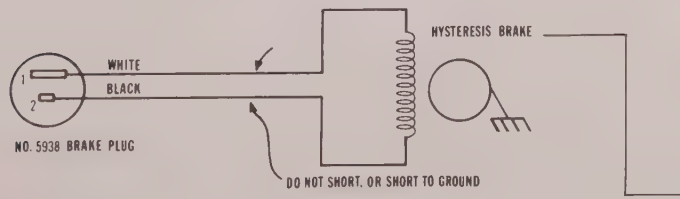
## MAGTROL WARRANTY

MAGTROL, INC. warrants that any equipment of our manufacture will be free of manufacturing or design defects to the extent that we will unconditionally guarantee equipment for a period of 90 days from date of receipt by the customer.

ADDITIONALLY, any repairs which may become necessary beyond the 90 Day Unconditional Warranty period will be made subject to complete review by our Quality Control and Engineering Department.

MAGTROL, INC.




① & ② ARE DECIMAL POINT LOCATERS:

GM. CM. ◄——► OZ. IN.

NO GROUND — HD 106 — GROUND PIN 12
GROUND PIN 12 — HD 400 — GROUND PIN 9
GROUND PIN 12 — HD 500 — GROUND PIN 9
GROUND PIN 9 — HD 700 — NO GROUND
GROUND PIN 9 — HD 705 — GROUND PIN 9
NO GROUND — HD 800 — GROUND PIN 9
NO GROUND — HD 805 — NO GROUND

GROUND PIN 9 = 00.0

GROUND PIN 12 = 0.00

RESISTANCE — HD 106 — 171 Ω
HD 400 — 80 Ω
HD 500 — 120 Ω
HD 700 — 80 Ω
HD 705 — 40 Ω
HD 800 — 60 Ω
HD 805 — 30 Ω
22 TO 27 VDC OPERATING — (F.S.) RES. TOL. ± 10%

NOTE 1. PART NO. TO BE FOLLOWED BY DYNAMOMETER MODEL NO.
EXAMPLE — 7338-700 FOR LOAD CELL ASSY. USED ON HD700.

NOTE 2. DRIFT (TEMPERATURE RELATED) COMPENSATOR. REF. TO INSTRUCTION MANUAL PAGE — 14

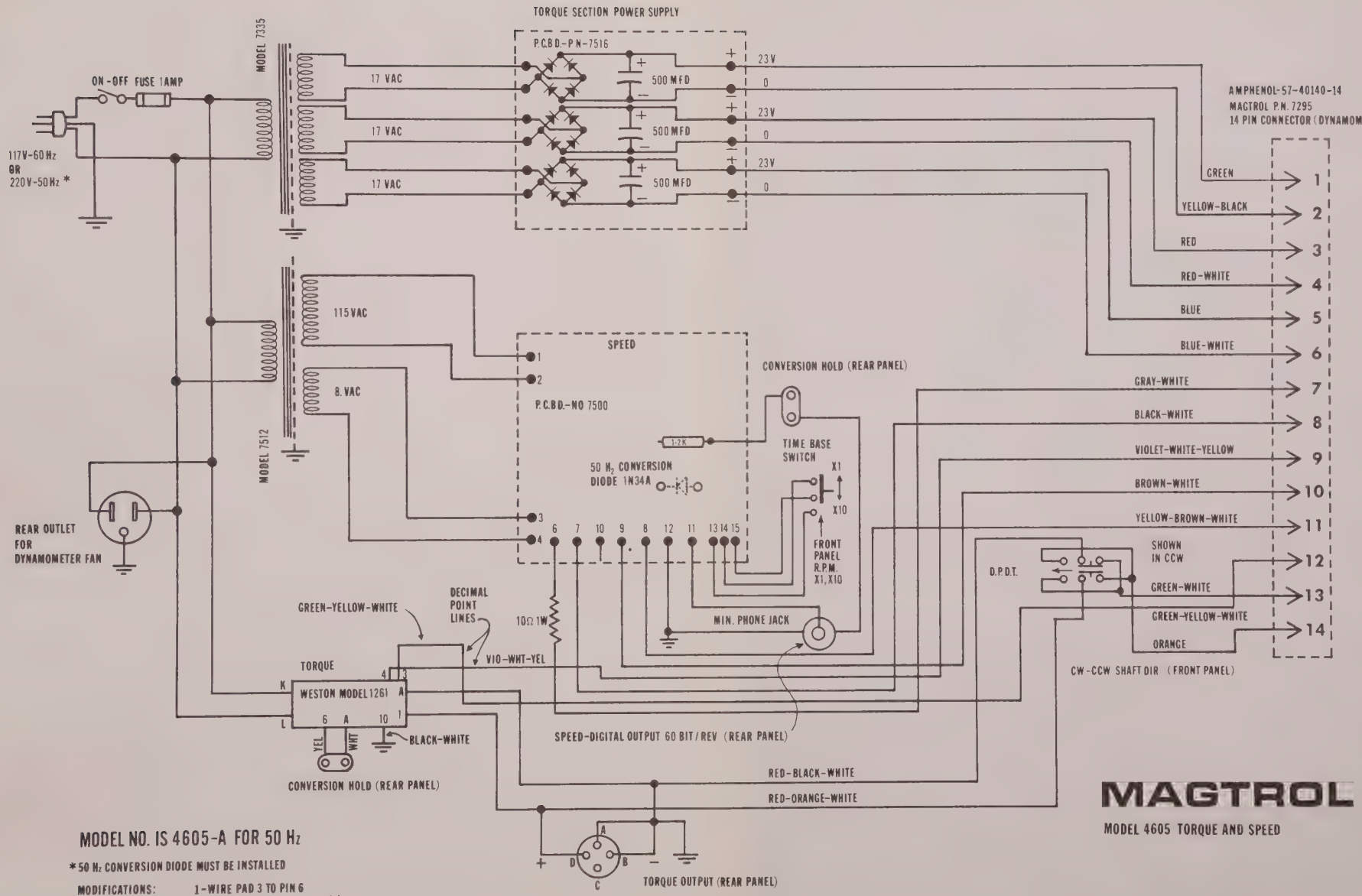
NOTE 3. GAIN CONTROL RESISTOR — 6 SERIES
HD — 106 — 475 K
HD — 400 — 340 K
HD — 500 — 1.0 MEG
HD — 700 — 340 K
HD — 800 — 1.0 MEG
HD — 805 — 178 K
HD — 705 — 464 K
1% MUST BE 20 P.P.M. M.F. OR W.W. °C

NOTE 4. ½W RES. VALUE DETERMINED BY INDIVIDUAL P.E. CELL REQ. REFER TO INSTRUCTION MANUAL PAGE — 12

* SENSOR NO. 7399

# MAGTROL

DIGITAL DYNAMOMETER SCHEMATIC — ALL MODELS




MAGTROL

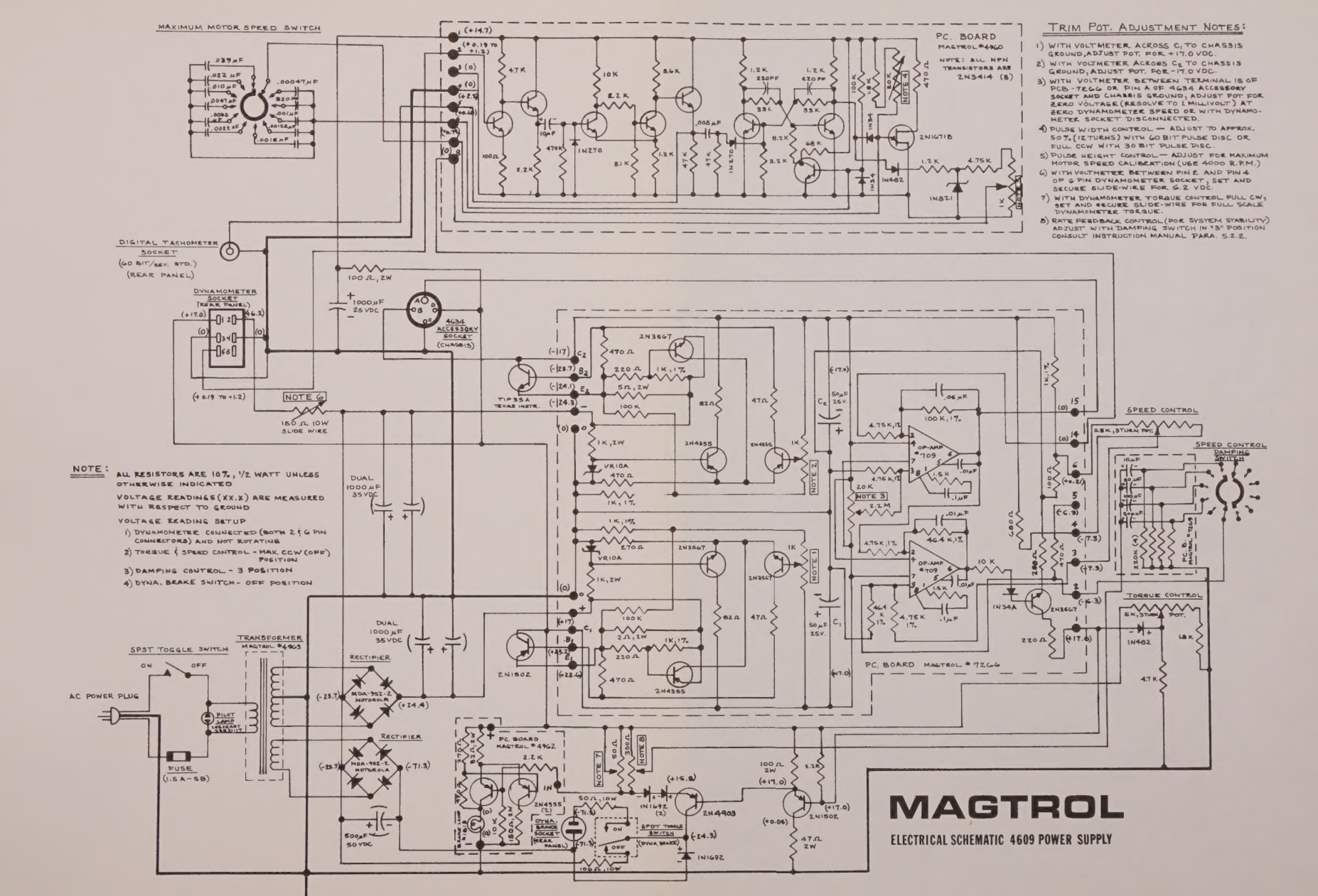
MODEL 4605 TORQUE AND SPEED

## MODEL NO. IS 4605-A FOR 50 Hz

* 50 Hz CONVERSION DIODE MUST BE INSTALLED

MODIFICATIONS: TO WESTON NO. 1261

1-WIRE PAD 3 TO PIN 6
2-WIRE PAD D1 TO PIN 4 =(00.0)
3-WIRE PAD D2 TO PIN 3 =(0.00)


MAXIMUM MOTOR SPEED SWITCH
PC. BOARD MAGTROL #4960
NOTE: ALL NPN TRANSISTORS ARE 2N3414 (5)
TRIM POT. ADJUSTMENT NOTES:
1) WITH VOLTMETER ACROSS C1 TO CHASSIS GROUND, ADJUST POT. FOR +17.0 VDC.
2) WITH VOLTMETER ACROSS C2 TO CHASSIS GROUND, ADJUST POT. FOR -17.0 VDC.
3) WITH VOLTMETER BETWEEN TERMINAL 15 OF PCB. #7666 OR PIN A OF 4634 ACCESSORY SOCKET AND CHASSIS GROUND; ADJUST POT FOR ZERO VOLTAGE (RESOLVE TO 1 MILLIVOLT) AT ZERO DYNAMOMETER SPEED OR WITH DYNAMOMETER SOCKET DISCONNECTED.
4) PULSE WIDTH CONTROL — ADJUST TO APPROX. 50 % (12 TURNS) WITH 60 BIT PULSE DISC OR FULL CCW WITH 30 BIT PULSE DISC.
5) PULSE HEIGHT CONTROL — ADJUST FOR MAXIMUM MOTOR SPEED CALIBRATION (USE 4000 R.P.M.)
6) WITH VOLTMETER BETWEEN PIN E AND PIN 4 OF 6 PIN DYNAMOMETER SOCKET; SET AND SECURE SLIDE-WIRE FOR 6.2 VDC
7) WITH DYNAMOMETER TORQUE CONTROL FULL CW; SET AND SECURE SLIDE-WIRE FOR FULL SCALE DYNAMOMETER TORQUE.
8) RATE FEEDBACK CONTROL (FOR SYSTEM STABILITY) ADJUST WITH DAMPING SWITCH IN "3" POSITION CONSULT INSTRUCTION MANUAL PARA. 5.2.2.
DIGITAL TACHOMETER SOCKET (60 BIT/REV. STD.) (REAR PANEL)
DYNAMOMETER SOCKET (REAR PANEL)
4634 ACCESSORY SOCKET (CHASSIS)
NOTE 6
150 Ω 10W SLIDE WIRE
TIP35A TEXAS INSTR.
2N3567
2N4355
2N4356
2N1502
NOTE 1
NOTE 2
NOTE 3
SPEED CONTROL
SPEED CONTROL DAMPING SWITCH
TORQUE CONTROL
OP-AMP 709
PC. BOARD MAGTROL # 7266
NOTE:
ALL RESISTORS ARE 10%, 1/2 WATT UNLESS OTHERWISE INDICATED
VOLTAGE READINGS (XX.X) ARE MEASURED WITH RESPECT TO GROUND
VOLTAGE READING SETUP
1) DYNAMOMETER CONNECTED (BOTH 2 & 6 PIN CONNECTORS) AND NOT ROTATING
2) TORQUE & SPEED CONTROL - MAX. CCW (OFF) POSITION
3) DAMPING CONTROL - 3 POSITION
4) DYNA. BRAKE SWITCH - OFF POSITION
SPST TOGGLE SWITCH
ON
OFF
AC POWER PLUG
PILOT LAMP
FUSE (1.5 A - SB)
TRANSFORMER MAGTROL #4903
RECTIFIER
MDA-952-2 MOTOROLA
PC. BOARD MAGTROL #4962
2N4355 (2)
2N4903
2N1502
DYNA. BRAKE SOCKET (REAR PANEL)
4PDT TOGGLE SWITCH (DYNA BRAKE)
1N1692 (2)
MAGTROL
ELECTRICAL SCHEMATIC 4609 POWER SUPPLY